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BRONCHIECTASIS AND CHRONIC LUNG ABSCESS FROM ASPIRATION OF A DENTAL BRIDGE

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BRONCHIECTASIS is a chronic disease which demonstrates types and degrees of dilatation and infection of the bronchial tree. The walls are usually thickened, and the mucosa may be covered with mucopurulent exudate in the involved areas. When foreign bodies find their way into the lung, the normal drainage of this area is prevented and infection follows.

The common symptoms of bronchiectasis are coughing and expectoration, with eventual chest pain. The sputum becomes purulent and has an offensive odor. Diagnosis of the disease should include a thorough history of respiratory difficulty, possible aspiration of foreign bodies, chest pain, etc. Roentgen-ray examination, following instillation of an opaque medium into the bronchial tree, will assist in the study of any anatomic changes that may be present. Foreign-body aspiration will usually involve only a portion of one lung, rather than both lungs.[1]

Lung abscess may be the result of aspiration of foreign bodies. The lower lobes are usually involved and, because of the anatomy of the bronchial tree, the right lung is the more common site.[2]

Symptoms of lung abscess include cough, expectoration, hemoptysis, chest pain, fever, and chills. Chronic abscess may be accompanied by anorexia and weight loss. Cerebral abscesses may complicate the disease, with serious consequences. Again, diagnosis requires a thorough history and careful evaluation of signs and symptoms, as well as assistance from the bronchoscopist.

Treatment is dictated by each individual case, with antibiotics and surgery being used in most instances of aspiration of foreign bodies.

CASE REPORT

The patient was a 34-year-old woman who, four years earlier, had suffered eclamptic convulsions during pregnancy. In one of these seizures the patient had unknowingly

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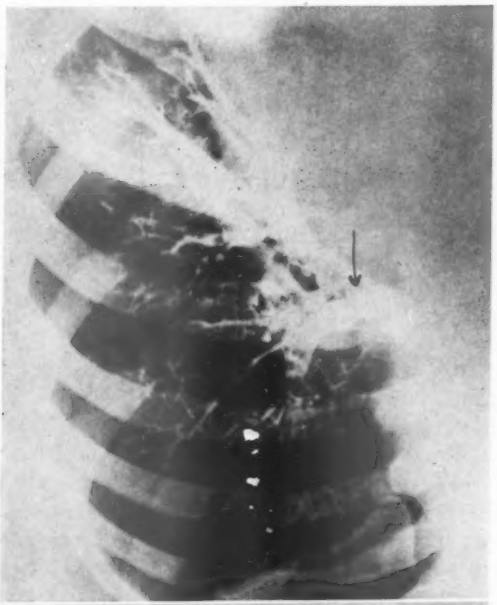
aspirated a three-tooth bridge into the left main bronchus. She related that she had experienced no pain in the chest until four years later, when she developed a productive cough and vague chest pain.

Fig. 1.



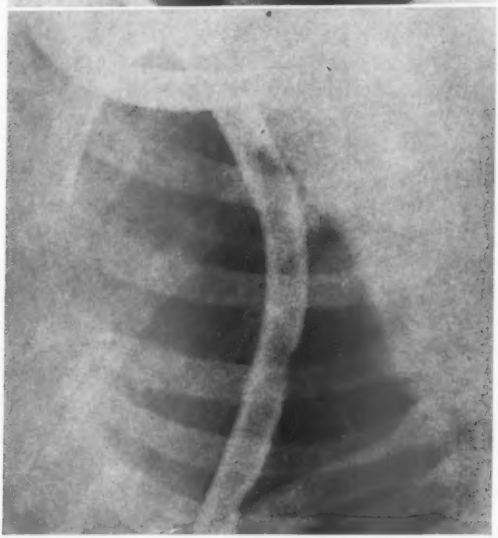


Fig. 2.

Fig. 1.—Roentgenogram showing three-tooth bridge in main right bronchus.
Fig. 2.—Film taken after removal of a portion of the lobe. A drain has been inserted.

Fig. 1 shows the bridge in the bronchus, with evident fibrosis and bronchiectasis peripheral to the appliance. Fig 2 shows the postoperative view following removal of a portion of the lower left lobe.

The removed portion of the lobe, with the bridge in place, is shown in Fig. 3. Immediately surrounding the bridge there was a very thick-walled abscess containing purulent material and debris. The exudate was cultured and found to consist of staphylococcus, streptococcus, and a type of fusiform bacillus.

Fig. 3.—The removed portion of the lung, showing the bridge in place. Note the abscess wall and fibrosis.

DISCUSSION

The unusual aspect of the foregoing case was the long duration of the foreign body implant with few, if any, apparent symptoms suffered by the patient. Since there is the possibility of aspiration without the usual signs and symptoms, roentgenograms should be made at the earliest possible time in cases in which foreign-body aspiration is suspected.

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THE USE OF HYPOCHLORITE FOR THE CONTROL OF BLEEDING

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INTRODUCTION

HYPOCHLORITE has been successfully used for the control of infection since the original work of Labarraque in the 1820's. During World War I, the Carrel treatment of wounds with Dakin's solution, a 0.5 per cent solution of sodium hypochlorite, and the use of eusol, another hypochlorite solution, achieved great fame and clinical success.[3, 4] Further work on the hypochlorite treatment of wounds, burns, and trench mouth during World War II established new and improved methods of using hypochlorite and increased the understanding of hypochlorite treatment.[1, 2]

This article deals not with the familiar properties of hypochlorite as an antiseptic in the control of infection but with the unfamiliar ability of hypochlorite to stop bleeding. I first called attention to hypochlorite's power to stop bleeding in 1941.[1] In 1945 I described in more detail the effects of rinsing the mouth with hypochlorite solution after oral surgery, both in stopping bleeding and in influencing the character of the clot.[2]

The hemostatic action of hypochlorite can be of great practical everyday use to the dental surgeon, and any dental surgeon can observe the striking hemostatic action for himself with the greatest of ease. If, after a tooth has been extracted, the patient rinses his mouth with 0.2 per cent hypochlorite solution, the surgeon will observe that in practically every case the bleeding is stopped promptly and permanently. Hypochlorite solutions have this striking power to stop bleeding only if they are concentrated enough, and they are nonirritating only if they are not too concentrated. The 0.05 per cent solution usually used as a mouthwash is too dilute to stop bleeding quickly and with regularity. The 0.5 per cent Dakin solution is unpleasant and irritating. Long experience has shown 0.2 per cent to be a suitable concentration.

The subject of the hemostatic action of hypochlorite will be discussed in three sections: (1) the preparation of the hypochlorite solutions, (2) the technique of using hypochlorite clinically, and (3) clinical observations.

No attempt will be made in this article to discuss the general subject of bleeding after oral surgery or the chemical mechanisms, about which little is known, whereby hypochlorite causes bleeding to stop and makes normal clots contract, harden, and become resistant to infection.

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Furthermore, this article will not present in any detail hypochlorite's other clinically important effects, such as cleansing of the mouth, reduction of inflammation, and control of infection. Since, however, the dental surgeon who uses hypochlorite to stop bleeding will be able to observe the other clinical effects, these will now be described very briefly.

The cleansing power of hypochlorite is just as easily observed as the hemostatic action. The 0.2 per cent hypochlorite used for hemostasis is as effective in the pre- and postoperative cleansing of the mouth as it is in the débridement of wounds generally. After the bleeding resulting from the extraction of a tooth has been stopped by the hypochlorite rinse, the mouth is free from unattached blood or blood clot and the patient notices no unpleasant bloody taste.

Sometimes the anti-inflammatory effect of hypochlorite is so rapid and dramatic that it can be observed at the time of the operation. Sometimes the anti-inflammatory effect can be demonstrated only by comparison of the appearance of the gingivae twenty-four hours after operation when hypochlorite is used postoperatively and when it is not used.

Finally, the well-known ability of hypochlorite to help in the control of infection can be checked only by the long-time observation of many cases.

However important and worthy of separate study the cleansing of the mouth, the reduction of inflammation, and the control of infection may be, hypochlorite solutions are well worth using just to stop bleeding.

THE HYPOCHLORITE SOLUTIONS

Commercial Hypochlorite Solutions.—A number of commercial solutions of sodium hypochlorite are readily available and are sufficiently pure, stable, and standarized to be suitable for dental use. The advent of stable standarized commercial solutions has rendered the less stable Dakin solution and eusol obsolete.

Milton and Zonite: The Milton solution sold in British chemist shops and the Zonite sold in American drugstores are 1 per cent solutions of electrolytically prepared sodium hypochlorite. These solutions contain 16.5 per cent sodium chloride in addition to hypochlorite.

Clorox: Clorox is a household bleach and sanitizing agent sold widely in the United States at a much lower price than Milton or Zonite. Indeed, the cost for medical quantities is negligible. Clorox is a 5 per cent stable solution of adequately pure sodium hypochlorite prepared by a chemical method. Clorox, in contrast with Milton and Zonite, contains very little sodium chloride.

There may be some prejudice on the part of patients against using a household bleach for medical purposes in the home.

At the present time, not all of the common British bleaching fluids are suitable for medical use.

Alkalinity: Milton, Zonite, and Clorox diluted to 1 per cent all have a pH of about 11. Solutions of pure sodium hypochlorite are fairly stable at this pH, much more stable than are neutral solutions.

Preparation of 0.2 Per Cent Hemostatic Solutions.—The Milton or Zonite containing 1 per cent sodium hypochlorite is diluted with four times its volume of lukewarm tap water. Although the exact concentration and temperature of the final hemostatic solution are not critical, any great deviation from 0.2 per cent and body temperature are to be avoided.

The 5 per cent Clorox solution cannot be diluted to 0.2 per cent by eye with adequate accuracy; the twenty-five-fold dilution must be done with measured volumes of Clorox and water. Alternatively, an intermediate 1 per cent solution can be prepared by accurate dilution of Clorox with four times its volume of water, and this 1 per cent solution then diluted roughly five times further.

Preparation of 0.05 Per Cent Mouthwash.—Milton, Zonite, or 1 per cent hypochlorite from Clorox is diluted with nineteen times its volume of warm water. This is roughly the equivalent of one tablespoonful to a glass. Again, the exact concentration is not critical.

Detergent.—It is often desirable to add a detergent, such as sodium lauryl sulfate, to the hypochlorite solution. The detergent reduces surface tension and masks the hypochlorite taste. A satisfactory concentration of detergent is obtained by adding one volume of a 2 per cent sodium lauryl sulfate solution to twenty-five volumes of hypochlorite.

Solid Hypochlorite.—Clorpactin, a proprietary product whose composition has not been disclosed, is a hypochlorite-generating powder buffered at about pH 5.5 which is made by the Guardian Chemical Company of Long Island City, New York. In the formulation promoted to dentists, it is called Kasdenol.

According to the label, the active ingredient of Clorpactin is "derived from calcium hypochlorite." The amount of calcium hypochlorite in the powder and the nature and the amounts of the other ingredients are not stated on the label.

Variables.—Unfortunately, there has not yet been a systematic and accurate clinical study of all the four variables that are known to be of significance—the concentration of hypochlorite, the pH, the addition of detergent, and the mode of application. It may well be proved that the best conditions for the use of hypochlorite will differ for different clinical applications.

CLINICAL USE OF HYPOCHLORITE

Precautions.—As in the use of household bleach, precautions must be taken to avoid the contact of even the relatively dilute dental hypochlorite solutions with clothing and other organic materials, some of which may be damaged or decolorized by hypochlorite. The patient is best protected with a plastic bib or apron.

After Simple Extraction.—The patient is given a tumbler of the warm 0.2 per cent hypochlorite solution. He is asked to rinse his mouth, pumping the solution back and forth past the site of extraction, and then to spit the solution into the dental spittoon or into a kidney dish held under the chin. If it seems desirable, the patient is told that the first rinse water will be dark brown and that this color is perfectly normal.

The rinsing is repeated until the rinse solution is colorless. This may take only a few rinses, a full tumbler, or occasionally two tumblers of hypochlorite solution. If more than one tumbler is needed, a wait of one minute is recommended before the use of the second tumbler. Usually, about half of one tumbler is needed. No dressing of any kind is put into the socket, and so far as bleeding is concerned, the patient can be dismissed without any waiting period.

On the rare occasions when bleeding is not stopped by the hypochlorite rinse, recourse to the familiar procedures described in the textbooks is necessary.

When a supplementary procedure is used to stop bleeding not stopped by the original hypochlorite rinse, this is followed by a second hypochlorite rinse.

Cases in Which There Is No Bleeding.—Occasionally, when a local anesthetic containing a vasoconstrictor is used, there is no bleeding after an extraction. The hypochlorite rinse is used even in such cases. The first effect is to initiate bleeding. Rinsing with hypochlorite solution is then continued in the usual way until the bleeding has stopped and the rinse is colorless. A firm, adequate clot is formed, as after spontaneous bleeding and hypochlorite rinse.

Fig. 1.

After More Extensive Surgery.—After single extractions involving cutting or bruising, after multiple extractions, and after such oral surgery as gingivectomy, a device controlled by the dentist, rather than simple rinsing by the patient, is preferable for effective irrigation.

A mouthpiece suitable for irrigation, which can be made of soft rubber or plastic, is pictured in Figs. 1 and 2. Attached to it is a Higginson's syringe or a mechanical pump. The mouthpiece is applied to the jaw that was operated upon, the patient is given a kidney dish to hold to the chin, and hypochlorite

solution is pumped through every five seconds until about one-half pint is used. If necessary, the irrigation is repeated. The used solution is received in the kidney dish.

An atomizer can be used instead of the irrigator, but it is less effective. Atomizers with chromium-plated or stainless steel metal parts are not damaged by hypochlorite, provided they are washed with water after use.

Preoperative Use.—If the mouth is exceptionally dirty or is badly infected, it is advisable that the mouth be rinsed, irrigated, or sprayed with hypochlorite solution before as well as after the operation. The use of an atomizer is especially effective for preoperative cleansing.

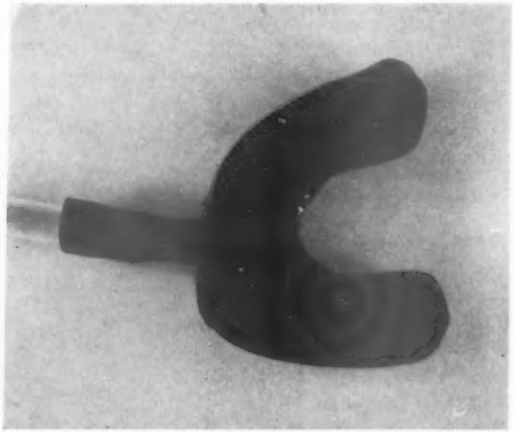

Fig. 2.

After General Anesthesia.—Hypochlorite solution is not applied to control bleeding during ordinary nitrous oxide anesthesia unless the throat is packed and the hypochlorite solution is constantly removed with a suction device.

Hypochlorite solution is applied after surgery performed under general anesthesia even if it has not been applied during anesthesia and even when bleeding has stopped before recovery, in order to take advantage of hypochlorite's action in cleansing the mouth, strengthening the clot, and reducing postoperative swelling.

Home Rinse.—Postoperative home rinsing is desirable rather than always essential. The patient is advised to rinse after meals, if possible, and certainly before retiring. He is given instructions for the preparation of the warm 0.05 per cent hypochlorite solution, warned against spilling hypochlorite solution on clothing or other material, and told about the possibility of brown stain.

Brown Stain.—In a small fraction of cases, a brown material is deposited on some teeth, especially after repeated hypochlorite rinsing of a mouth with inflamed gingivae. This brown deposit is not removed by ordinary brushing of the teeth but is easily removed by the usual polishing brush and, indeed, can

be rubbed off by the patient with a handkerchief or other soft cloth and moistened dentifrice powder. The brown deposit is a superficial, removable material, not a discoloration of the tooth substance.

CLINICAL OBSERVATIONS

Time of Hemostasis.—As is well known, the time it takes for bleeding to stop spontaneously is variable and depends upon the patient, the type of anesthetic used, and the amount of trauma inflicted. Similarly, the time for hypochlorite hemostasis is variable. On the average, however, the hypochlorite hemostasis takes place much faster than the spontaneous stopping of bleeding. Sometimes hypochlorite hemostasis seems almost instantaneous. Usually it takes less than one minute.

Certainty of Hemostasis.—No statistical results are available. I can say from long experience, however, which has been confirmed by the experience of other dental surgeons, that the failure of hypochlorite to stop bleeding is much more rare than the failure of bleeding to stop spontaneously. When bleeding has failed to stop spontaneously, it can often be stopped by the hypochlorite rinse.

Color and Surface Appearance of Clot.—The clot seen after a hypochlorite rinse is darker than the usual spontaneous clot, but it turns yellowish gray after a few hours. Throughout this period, the clot is covered with a glistening film.

A histologic examination of a clot after twenty-four hours shows massive invasion with histiocytes, which probably accounts for the grayish color, and a surface layer of condensed cells, not yet identified, which may account for the glistening film.

Physical Character of the Clot.—The normal, spontaneous clot is a soft, jellylike mass which fills the socket and often is not attached very firmly. In contrast, the hypochlorite clot fills only a portion of the socket and is both denser and more firmly attached than the spontaneous clot. The hypochlorite clot cannot be rinsed away or even easily removed with forceps.

Effect of Hypochlorite on Spontaneous Clot.—The appearance, physical character, and firmness of attachment of a clot is much the same whether the hypochlorite is applied right away or after a spontaneous clot has formed.

M. L. Anson and I have observed that the addition of hypochlorite to a piece of spontaneous clot in vitro causes an immediate considerable concentration of the clot, with the formation of a dense material which is attacked and dissolved by 0.2 per cent hypochlorite solution only very slowly.

Appearance of the Mouth.—Most striking is the complete absence of all free blood or clot. Hypochlorite solution cleanses the mouth after operation much more effectively than the usual mouthwashes.

Hypochlorite affects the traumatized gingivae as well as the bleeding and the clot. The margins of the socket are contracted after the hypochlorite rinse. Where incisions have been made, the edges are usually in apposition and sutures are seldom required.

Observations of the Patient.—After the hypochlorite rinse, the patient is aware of no order or taste of blood in the mouth, as is to be expected from the effective cleansing. If home rinsing is carried out, there is no later odor or taste of blood.

Patients do not complain of any sting or pain during the application of hypochlorite solution. Furthermore, the general experience is that the hypochlorite rinse reduces postoperative pain and swelling.

Some patients may be disturbed by the dark brown color of the first rinse if not told about this in advance.

SUMMARY

1. Simple rinsing of the mouth with 0.2 per cent hypochlorite solution stops postoperative bleeding in almost every case, usually within less than one minute.

2. If bleeding has failed to stop spontaneously, it usually can be stopped by a hypochlorite rinse.

3. The hypochlorite clot is more dense and contracted than a spontaneous clot, and it is more firmly attached to the socket.

4. If hypochlorite solution is applied after spontaneous clotting has taken place, the clot becomes contracted and more firmly attached.

5. In addition to stopping bleeding and changing the character of the clot, the hypochlorite rinse cleanses the mouth of free blood and clot and reduces swelling of traumatized gingivae.

6. The application of hypochlorite solution causes no pain and often diminishes postoperative pain.

I wish to thank Dr. M. L. Anson for his help in the writing of this paper.

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RESECTION OF THE UPPER JAW AND ITS IMMEDIATE RESTORATION

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TO SPEAK of the resection of the upper jaw is to consider the malignant tumors of this bone, the salient parts of which represent, as Cornet[1] puts it, the easel that supports the whole face.

From a histologic point of view, malignant blastomas include carcinomas and sarcomas.

With Bureau,[1] we shall define *carcinomas* of the upper jaw as primitive tumors of the adjacent soft parts—mucosae and glandular organs—which then invade the bone, this encroachment being characterized by its precocity. On the other hand, *sarcomas* of the upper jaw are tumors that usually occur in the second or the sixth decade of life and have a different histogenesis, since they originate in the intraosseous tissues of the osteoformative system and come to the surface or invade the adjacent tissues.

If these tumors are considered on the basis of their symptomatology, a great similarity is to be found between them. Nine out of ten, however, are carcinomas.

Sebileau's[2] well-known topoclassification, established in 1906, has been accepted up to now and is still being used for didactic purposes. According to it, the tumors of the upper jaw are divided into three groups: *tumors of the suprastructure,* that is, of the ethmoido-maxillo-orbito-nasal region; *tumors of the mesostructure,* the nasosinusal tumors, among which that described by Verger[10] is included; *tumors of the infrastructure,* the palatoalveolar ones, including the clinical form described by Hautant[3] and excluding the inaccurately denominated mixed tumors of the palate.

In spite of the existing classifications, it should be pointed out that it is extremely difficult to determine with precision the place where the tumor actually started.

Tumors of the upper jaw are relatively rare; only 0.2 per cent of all carcinomas are found there. They are more common in men than in women, the proportion being 3 to 1. Average ages at which they occur are 56 years in men and 63 years in women.

From Instituto Buco Maxilo Facial, Av. Gral. Rodriguez 8616, Lomas de Zamora.

The tumors are not detected at their initial stages, and their silent evolution makes their diagnosis difficult. Not being primitively buccal, they are not discovered until they become manifest.

A trismus with no apparent cause, mobility of the teeth, running eyes, a slight exophthalmos, and a paresthesia of the suborbital region may be premonitory symptoms that lead to the diagnosis.

Care should be taken to differentiate these malignant tumors from sinusitis of either dental or nasal origin (particularly the hyperplastic forms), osteitis of dental or sinusal origin, and abscesses and benign tumors of odontogenic origin. The surest methods of differentiation are front, profile, and submentovertical roentgenograms, the tomogram, and the biopsy.

Fig. 1.

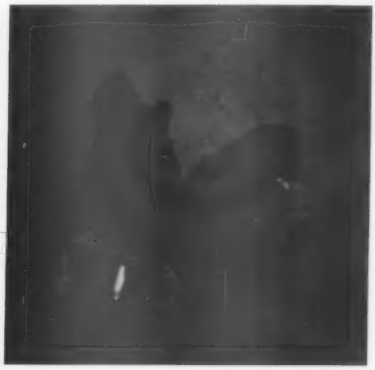

Fig. 2.

Fig. 1.—View of the tumor.
Fig. 2.—Resected portion of the upper jaw bearing tumor.

The prognosis is directly dependent on the diagnosis. The lower the tumor is located and the less the ganglia are invaded, the more precocious is the diagnosis.

The quick detection of the malignant maxillofacial tumors is extremely important. As Thoma[8] and Salman and Langel[7] point out, it depends largely on a close relationship between the dental and the medical professions.

According to the statistics of Sharp, Bullock, and Hazlet,[4] only 15 per cent of the patients are free from recurrence three years after treatment. The American Cancer Society[5] mentions a 27.5 per cent recovery rate in all cases of carcinoma of the paranasal sinuses treated at the Massachusetts Eye and Ear Infirmary over a period of more than fifteen years. The French school has systematized surgery followed by radium therapy; the latter is masterfully handled, thus compensating for insufficient surgery. In tumors of the infrastructure they obtain an 80 per cent control, and in those of the mesostructure a 37 per cent control is obtained. If we are to take these statistical figures into account, we must bear in mind the fact that the North American authors use

a different classification; their data refer exclusively to the carcinomas of the paranasal sinuses, since they classify those of the infrastructure as oral tumors.

Whether the starting point of the blastoma has been the buccal mucosa (the peripheral form described by some authors), or whether it has been the paranasal sinuses (central form), the therapeutic indications are the same: total excision either preceded or followed by intracavitary irradiation.

We shall now outline the plan that we follow:

1. Improvement of the conditions of the mouth. This is very important, and we have observed that it is not systematically done everywhere. Before any surgical treatment is begun, the oral cavity should be thoroughly cleaned; all the bridges and metal prostheses should be removed if it is necessary to resort to irradiation either at the beginning or at the end of the operation.
2. Complete electrosurgical excision.
3. Intracavitary application of either radium or cobalt.

Fig. 3.—Moore's incision.

The resection of the upper jaw requires a wide exposure of the bone. The incisions described by Farabeuf, Fergusson, Liston-Nelaton, Duffenbach, Weber, Moore, etc., are the ones most frequently used, as they enable the surgeon to lift up a large flap and thus expose the bony bridges that connect the maxilla with the other bones of the face.[6, 8, 9] It is to be pointed out that the above-mentioned incisions make it possible to spare the branch of the facial nerve, with the additional advantage that the subsequent suture will leave a scarcely visible scar.

In order to extirpate the whole tumor, the wide electrosurgical resection of the maxilla is effected by incising through healthy tissue, which causes an important loss of matter and creates a wide gap communicating directly with the neighboring cavities. This, of course, results in a pronounced deformity of the face. It should be mentioned that the upper part of the orbit is seldom encroached upon by the tumor.

We have tried to counteract the resulting morphologic alteration by performing plastic surgery with flaps and grafts or by using surgical prostheses. The use of grafts recommended by Martin[9] is not possible when the combined

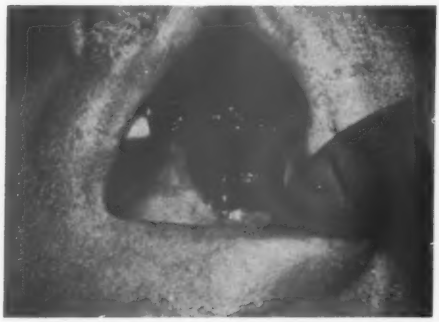

Fig. 4.

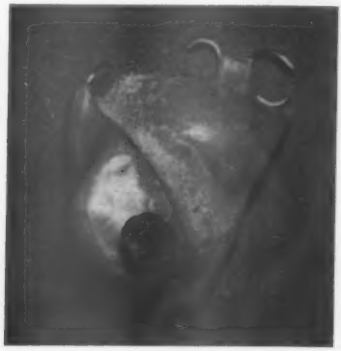

Fig. 5.

Fig. 4.—Postoperative course.
Fig. 5.—Prosthesis of restoration. The sinus is reconstructed and contains the radioactive implant.

Fig. 6.

Fig. 7.

Fig. 6.—Roentgenogram showing the implant.
Fig. 7.—The patient after three years.

methods are employed. The prosthesis that we use is made by reconstructing, a priori, all the walls of the jaw to be extirpated and applying them immediately after the operation.

The shape given to our prosthesis offers the following advantages:

1. It serves as an element of support, tamponage, and compression of the residual tissues, and it even supports the eye socket when it is necessary that the floor of the orbit be removed.

2. It improves the cosmetic aspect by replacing the anterior wall of the maxilla and thus preventing depression of the cheek.

3. It isolates the nasal fossae and the oral cavity from the zone of resection.

4. At the same time, it makes it possible to feed the patient without using a tube.

5. The cavity in the prosthesis, which simulates the maxillary sinus, holds the radioactive implants that are indispensable to completion of treatment.

6. With this prosthesis, the characteristics of the patient's phonetization remain very similar to those that existed before the operation.

7. It prevents the deformation of the soft parts, as it controls to a great extent the retraction of the scar.

The entire prosthesis ensures greater postoperative comfort and mitigates, at least partially, the severity of the process, since it prevents the patient from feeling the full extent of the mutilation.

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ADENOAMELOBLASTOMA

Report of Three Cases

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THERE are several histologic types of ameloblastoma, including the melanoameloblastoma, the acanthomatous ameloblastoma, and the adenoameloblastoma. The ameloblasto-odontoma and the malignant ameloblastoma are two additional types mentioned by Thoma.[1] The adenoameloblastoma has been thought to be an uncommon type, although the number of reports of this tumor that have appeared during the past eleven years[2-8] would seem to indicate that since it was first described by Stafne[2] in 1948 it has come to be recognized as a distinct entity.

The adenoameloblastoma is characterized by glandular as well as dental epithelium, with a scanty stroma of connective tissue. These cells are arranged in nests, cords, sworls, or ducts. They may be columnar or cuboidal in nature.[9] Other features include (1) low mitotic activity, (2) scattered foci of calcification, (3) occasional occlusion of the ductlike structures by epithelium, (4) nuclei of duct-lining cells located away from the lumina, (5) absence of cells resembling the stellate reticulum, and (6) the occasional presence of material in the lumina of ducts. Lucas[7] reasons that this material is "pre-enamel" formed by the lining cells, and this view has been supported by Gorlin and Chaudhry,[8] who have found that it is an acid mucopolysaccharide.

CLINICAL FEATURES

Adenoameloblastoma occurs in females twice as frequently as in males (on the basis of nineteen published cases), and it occurs most frequently between the ages of 10 and 20 years. It is commonly associated with unerupted teeth. It causes swellings which are generally painless. Roentgenographically, it is difficult to differentiate from the follicular cyst. It does not tend to recur after curettage.

Gorlin and Chaudhry[8] have concisely summarized the findings in the nineteen cases reported up to 1958. When the most recent case in our series (Case 1) came to our attention, we reviewed the files of our Department of Pathology

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and noted two more cases of adenoameloblastoma. These had been mentioned among a series of bone tumors in a report from that department which was read at the sixth annual conference of the Indian Association of Pathologists in 1955.

CASE REPORTS

CASE 1.—A 10-year-old South Indian girl was referred to the Department of Dental and Oral Surgery in July, 1959, complaining of a swelling over the anterior aspect of the left maxilla. This lesion had first been noted two months previously.

Fig. 1.

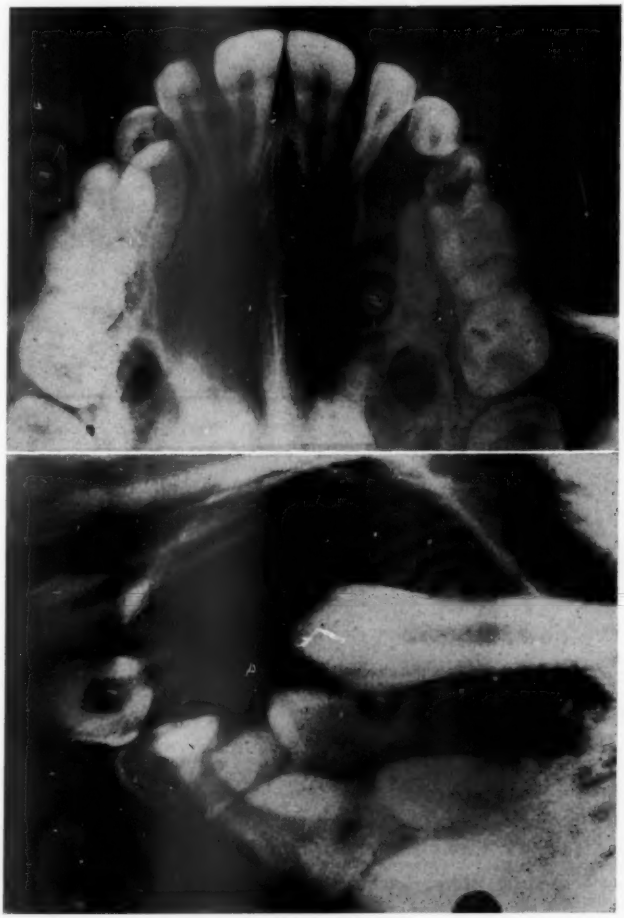

Fig. 2.

Fig. 1.—Case 1. Tumor associated with an unerupted cuspid in a 10-year-old girl. Note the thin shell of bone covering the tumor.

Fig. 2.—Case 1. Roentgenogram which led to a preoperative diagnosis of central follicular cyst.

Examination revealed a firm, nontender swelling which measured approximately 4 by 4 cm. The swelling was oval in shape and extended from the lateral margin of the left external naris posteriorly. Intraorally, it extended into the buccal sulcus from the lateral incisor to the first premolar region to a point 1 cm. above the gingival margin. There was moderate deflection of the lateral aspect of the left external naris.

Fig. 3.

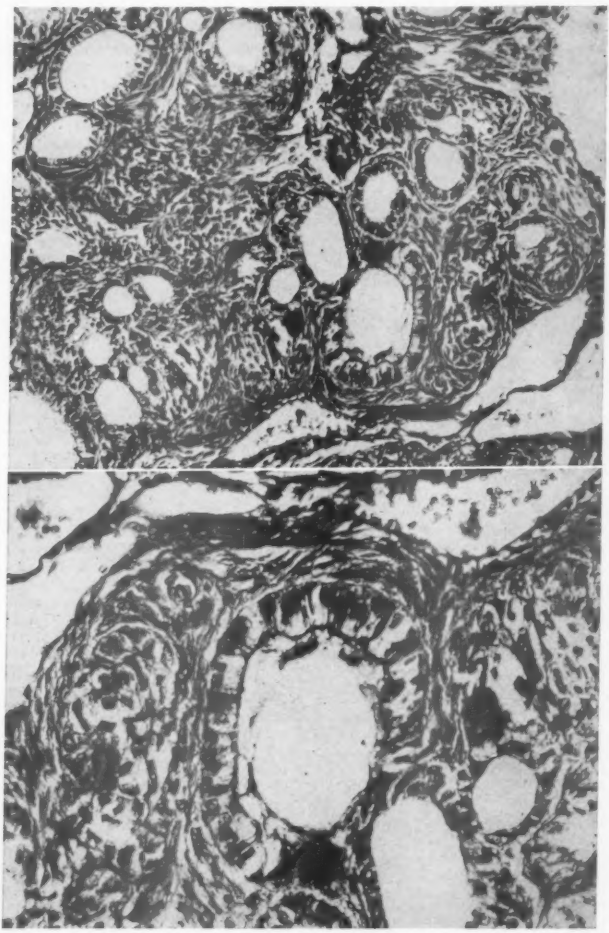

Fig. 4.

Fig. 3.—Case 1. Low-power photomicrograph demonstrating multiple ductlike structures with scanty connective tissue stroma. Note foci of calcification.

Fig. 4.—Case 1. High-power photomicrograph demonstrating both columnar and cuboidal duct cells, with nuclei placed away from the lumina.

X-ray examination revealed a radiolucency, approximately 3 by 3 cm., involving the crown and part of the root of the unerupted left maxillary cuspid (Figs. 1 and 2). All teeth were vital.

The preoperative diagnosis was follicular cyst.

Following induction of general anesthesia, the left maxilla was infiltrated with 1 per cent procaine containing epinephrine. A linear incision was made 0.5 cm. above the gingival margin from the second molar to the central incisor. The mucoperiosteum was reflected, exposing the tumor which was covered by a thin shell of bone (Fig. 1). This was removed with rongeurs. As soon as the cavity was entered, approximately 3 c.c. of a thin, straw-colored fluid escaped. The defect was filled with a grayish tissue of liverlike consistency. This tissue was not adherent to the cavity walls and was easily removed with the cuspid and with the first premolar, which was in intimate relation to the tumor. The walls of the defect were curetted and treated with phenol followed by alcohol. The margins were smoothed with bone files, and the incision was closed with 000 cotton interrupted sutures. The maxillary sinus was not continuous with the defect.

Microscopic examination revealed the typical pattern of adenoameloblastoma (Figs. 3 and 4).

Sutures were removed on the sixth day following surgery, and the patient made an uneventful recovery.

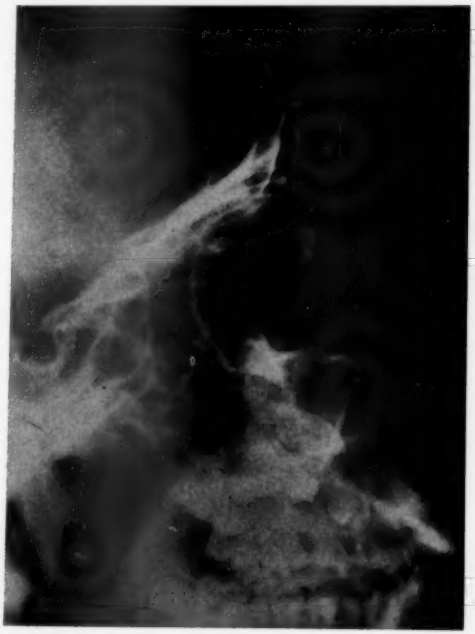

Fig. 5.—Case 2. Preoperative roentgenogram showing an unerupted cuspid high in the maxilla of a 12-year-old boy. This was associated with elevation of the floor of the nose.

CASE 2.—A 12-year-old South Indian boy was admitted to the Christian Medical College Hospital in June, 1955, complaining of tenderness of five days' duration in a mass in the left side of the face. The tumor had first been noted one month previously.

Examination revealed a hard, tender, bony swelling, approximately 4 by 4 cm. in size, over the left maxilla. This extended into the lateral wall of the left nostril anteriorly, blocking almost the entire internal naris. The floor of the nose was elevated on that side. The tumor extended inferiorly, causing an egg-shaped deformity in the maxillary alveolus

above the cuspid region. There was slight bulging of the palate on the left side opposite the cuspid region.

Roentgenograms revealed an unerupted cuspid in intimate relation to the tumor (Fig. 5). The preoperative diagnosis was dentigerous cyst.

Fig. 6.

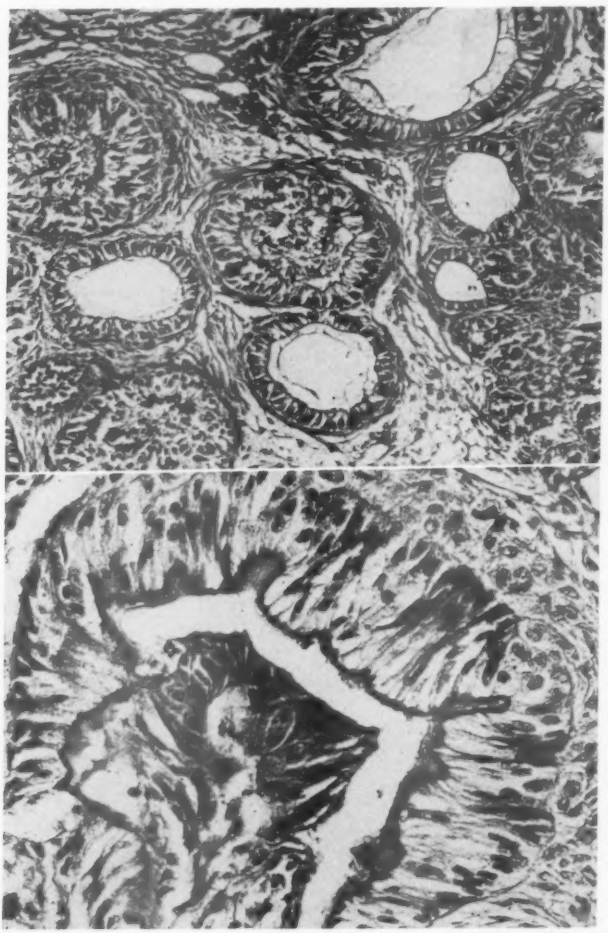

Fig. 7.

Fig. 6.—Case 2. Low-power photomicrograph. Occlusion of two of the ducts with epithelial cells may be seen, as well as the presence of an eosinophilic material in other ducts, presumably elaborated from the duct cells.

Fig. 7.—Case 2. High-power view of one of the ducts. Note absence of mitotic figures. The material in the duct is eosinophilic and, because of its mucopolysaccharide nature, is thought to be "pre-enamel."

Following induction of general anesthesia, an incision was made above the necks of the teeth. The mucoperiosteum was reflected and a thin shell of bone was removed, after which the tumor was enucleated. An antrostomy was performed, and the nose was packed with petrolatum gauze. The incision was closed with 000 cotton sutures.

Fig. 8.—Case 2. Roentgenogram taken more than four years after operation. There is no evidence of recurrence of the tumor.

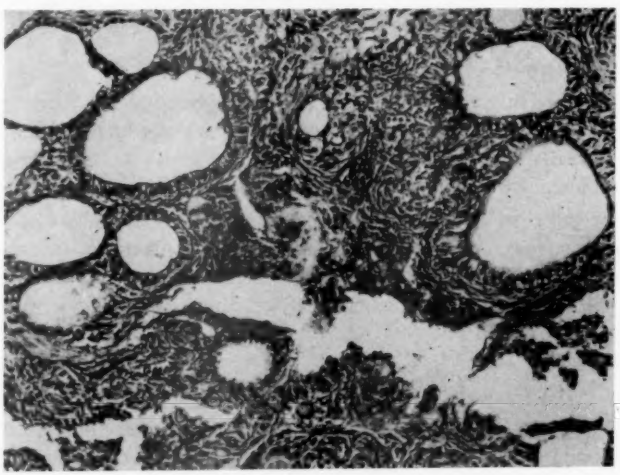

Fig. 9.—Case 3. Low-power microscopic appearance of a tumor removed from a 25-year-old woman. Note typical arrangement of ducts and absence of stellate reticulum.

Microscopic examination disclosed adenoameloblastoma (Figs. 6 and 7).

The pack was removed after two days, and the sutures were removed in five days.

The patient was examined in August, 1959, four years and two months following surgery. There was no evidence of nasal pathology, and roentgenograms showed no evidence of recurrence (Fig. 8).

CASE 3.—A 25-year-old South Indian woman was admitted to the Christian Medical College Hospital in March, 1945, complaining of intermittent pain over the right maxilla which had been present for the past four months. This had begun as a toothache, but soon the patient had noticed a swelling which had increased in size rapidly during the previous two months, causing difficulty in breathing through the right nostril.

Examination revealed a nontender, firm swelling over the right maxilla, involving the right nostril and lower eyelid. Several of the maxillary teeth were mobile. There was moderate swelling of the right side of the palate.

X-ray findings were reported as indicating a "cyst with a tooth near the orbit."

Following induction of general anesthesia, an incision was made above the margin of the gingiva in the right maxilla. The lesion was removed, and the cavity was irrigated. The incision was closed with interrupted sutures.

Microscopic examination revealed the typical pattern of ducts and strands of ameloblasts with little connective tissue (Fig. 9).

This patient has never returned for postoperative follow-up.

DISCUSSION AND SUMMARY

The three new cases of adenoameloblastoma presented here bring the total number of reported cases to twenty-two. In all three of our cases the tumor occurred in the maxilla. Thus, the maxilla was involved in fourteen and the mandible in eight of the twenty-two reported cases.

The tumors in the three cases reported here occurred in two female patients and one male patient. Therefore, the 2:1 ratio of females over males is maintained (fifteen females, seven males). All of these tumors were associated with unerupted or impacted teeth.

Our three patients were aged 10, 12, and 25 years, a fact which strengthens the impression that this tumor occurs in a younger age group than the ameloblastoma. The 10-year-old girl in Case 1 of our series is the youngest patient in whom adenoameloblastoma has been reported to date.

It is our impression that many cases diagnosed as ameloblastoma or simply as radicular cyst may actually have been adenoameloblastoma and that a review of slides from such cases might yield a significant number of rediagnoses. This, in turn, would give further information regarding the incidence, diagnosis, and prognosis of this condition.

ADDENDUM

Since this article was accepted for publication, we have encountered another case of adenoameloblastoma. This occurred in a 15-year-old South Indian girl who gave a two-month history of a painless swelling of the anterior aspect of the left maxilla. This tumor had the same clinical, x-ray, and microscopic appearance as Case 1 of this series. It, too, was associated with an unerupted

permanent cuspid tooth, the deciduous cuspid being present in the maxillary arch. It has been treated by enucleation and treatment of the bony walls with phenol followed by alcohol.

The authors wish to extend their thanks for helpful assistance to Drs. E. W. Gault, J. Thomas, and A. Bhakthaviziam of the Department of Pathology, Dr. A. J. Patt of the Department of Ear, Nose, and Throat, and Mr. Sigamani of the Photography Department of the Christian Medical College Hospital.

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EXODONTIA

A STUDY OF DRY SOCKETS

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INTRODUCTION

LOCALIZED osteitis, or "dry socket" as it is more commonly called, has always been a thorn in the side of the exodontist. His inability to prevent this complication and his limitations where effective treatment is concerned have caused him to suffer along with the afflicted patient. It is only recently that the probable mechanism and effective treatment have been postulated,[2-4] and the total process is still not completely understood. Among the various causes suggested by leading authors are mechanical trauma to bone and soft tissue, dense bone and, consequent poor blood supply at the operative site, infection from pre-existing sources or new contamination, mechanical loss of blood clot, excessive vasoconstriction from anesthetics, and the presence of foreign bodies or diseased tissue.

The acuteness of the problem has caused us to attempt to determine the main cause of socket complications. Because the lower third molar area is the most frequent site of localized osteitis, it is the logical area in which to concentrate a study of the problem.[1] A form which included as many causative agents as possible was drawn up and filled out completely for each patient. It is hoped that the results of this pilot study will be the basis for more extensive future probes into the problem of localized osteitis.

METHOD

A group of unselected patients with third molar impactions of varying severity were evaluated before, during, and after operation. There were fifty men and forty-six women, mostly of college age. The only criterion for

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selection of the subjects was the recommendation that the impactions be removed. An extensive history was obtained from each patient before the operation; this included information concerning previous inflammation, pain, or infection at the surgical site and completion of a general health questionnaire. The length and severity of the operation and observations as to whether the patient was calm or apprehensive were recorded during the procedure. The type and amount of local anesthesia were held constant for all extractions. Most patients were seen twenty-four hours after the operation and then on following days as indicated, at which time the following were evaluated: amount of clot loss, odor, oral temperature, pain, bone exposure, presence of pus, inflammation of the surgical area, and whether the patient said that he followed the postoperative instructions.

Postoperative instructions in the Oral Surgery Department at the State University of Iowa consist of the following:

1. The day of operation:
   (a) Keep damp gauze packs in place for thirty minutes with constant firm pressure.
   (b) Do not rinse mouth or suck on the wound.
   (c) Avoid excessive expectoration, exercise, and smoking.
   (d) Keep head elevated and rest quietly.
   (e) Apply ice bag for thirty-minute intervals to control swelling.
   (f) Take prescibed tablets (APC) for pain if needed.
2. The first postoperative day and throughout healing period:
   (a) After meals, brush teeth and rinse mouth with warm saline.
   (b) Your diet may be soft to regular as desired.
   (c) External heat (heating pad, hot-water bottle) is helpful when applied to face on the same side.
   (d) Continue with tablets for pain if needed.

Clot breakdown and loss was used as the basic criterion for the severity of socket complications, since its presence is almost invariably connected with the other symptoms of localized osteitis, such as odor, bone exposure, pain, swelling and lymphadenitis.

Amount of clot loss was determined by the amount of firm, healthy clot remaining in the socket (in other words, that which remained after irrigation and firm wiping-out of the debris with a cotton pellet) as compared to the approximate size of the original defect. The socket was probed with cotton pliers to determine clot consistency. The odor and appearance of the material clinging to the plier tips, as well as the contents of the socket, were carefully noted.

The subjective nature of many of these signs, especially those involving only the patient's word, is an admitted weakness. Many times, however, this is the only way to get an indication of the desired information.

DISCUSSION

It was found that our results bore out the findings of previous studies[1, 2, 4] that the amount of surgical trauma is proportional to the degree of complications. Of our patients who had more than one-half clot loss, 60.4 per cent had undergone procedures listed in the most traumatic category (Table I).

TABLE I

	TYPE OF PROCEDURE*			
	CLASS I	CLASS II	CLASS III	CLASS IV
No clot loss	3	1	0	5
Less than one-half clot loss	1	5	10	5
Over one-half clot loss	1	7	32	25

*Class I = Tooth elevated, no flap.
Class II = Flap, no bone removed.
Class III = Flap, bone removed, tooth elevated.
Class IV = Flap, bone removed, tooth sectioned, or other severe procedure.

Another significant finding was that in 51 per cent of the cases in which clot breakdown occurred, these changes were evident within twenty-four hours (the first postoperative day). Twenty-three per cent of clot-breakdown patients showed changes at forty-eight hours (the second postoperative day). Many of these patients who were seen for the first postoperative appointment forty-eight hours after surgery were unable, for various reasons, to return on the first postoperative day. Therefore, it is possible that many of these patients showed changes earlier. The staff felt that early diagnosis and intervention by vigorous treatment of those sockets that showed early degenerative changes made it possible for us to "head off" or modify the severe symptoms and perhaps shorten the healing course. Our method of treatment of localized osteitis consists of three groups:

1. Irrigation of the socket to remove degenerating clot and necrotic tissue.
2. Isolation of the socket by drying involved tissues and placing gauze or cotton rolls on each side of the ridge.
3. Medication.
   A. Exposed bone is gently painted with a saturated solution of iodine and guaiacol to desensitize and deodorize the tissues.
   B. Analgesics are given systemically for pain.
   C. A postoperative dressing* is inserted into the socket. This dressing serves several purposes. It is soothing because of the zinc oxide; it has a sealing quality against oral fluids and

Formula:
Polymyxin B sulfate, 20 mg. to inhibit bacterial growth.
Bacitracin soluble tablets, 10,000 units to inhibit bacterial growth.
Balsam of Peru, 2 Gm. to provide smoothness.
Oil of peppermint, 4 drops for flavor.
Zinc oxide ointment, 20 Gm. as vehicle.
This is mixed into a smooth white paste and incorporated into a ¼ inch selvage gauze strip. The strip is stored in a dark bottle in a cool place, and the desired length is cut as needed from each sterile bottle.

debris because of the ointment; and it is antibacterial. Organisms which have been isolated from patients with localized osteitis include[1]:

Gram-Positive	*Gram-Negative*
Actinomyces bovis	*Hemophilus influenzae*
Corynebacterium diphtheriae	Coli-aerogenes bacteria
Neisseria meningitidis	Klebsiella species (undifferentiated)
Diplococcus pneumoniae	*Pseudomonas aeruginosa*
Streptococcus species (undifferentiated)	Pseudomonas species (undifferentiated)
Micrococcus species (undifferentiated)	

It is on this basis that the antibiotic combination is chosen, bacitracin being essentially for gram-positive organisms and polymyxin B for gram-negative organisms. This provides a broad-spectrum antibiotic range to retard bacterial growth within the socket. The dressing is changed every two to five days until healthy granulation tissue is present.

It was also determined by clinical observation that, on the average, granulation tissue was first evident in the socket nine and one-half days following the surgical procedure, with an over-all range of from five to twenty-one days. This granulation tissue marks the initiation of the actual healing process and the end of the localized osteitis phase.

Included in the study were thirteen patients who had both lower third molars extracted at different sittings. This provided an opportunity to compare the patients' responses and the healing properties of similar surgical sites. In the patients who showed different responses in the two surgical sites values of technical difficulty and actual operative trauma were found to be similar in the two sides. Of the patients who showed a difference in response, seven showed a marked improvement over the first operation, both in healing time and in the smaller number of complications, and two had a more severe reaction following the second procedure. The improvement may be explained by the fact that patients who have gone through the experience once are more susceptible to suggestions that promise to help them avoid similar extraction complications.

In the main part of the study no correlation was found between amount of clot loss and amount of apprehensiveness, previous or existing infection of the surgical site, length of the operation, or carrying-out of recommended postoperative instructions.

CONCLUSIONS

1. The amount of surgical trauma was again found to be proportional to the degree of socket complications.

2. Indication of clot breakdown in patients developing socket complications was found to be evident after only twenty-four hours in more than one-half of the cases studied. This permitted earlier intervention of the process.

3. Our method of treating localized osteitis is discussed.

4. Evidence of granulation tissue of secondary healing was first noted, on the average, nine and one-half days after surgery.

5. Patients who had undergone similar extraction procedures in both sides showed a marked improvement on the second side, both in healing time and in number of complications.

6. No correlation was found between clot loss and amount of apprehensiveness, previous or existing infection of the surgical site, length of the operation, or following of recommended postoperative instructions.

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PERIODONTICS

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DENTAL CALCULUS

A Biophysical Study

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INTRODUCTION

DENTAL calculus is usually classified as supragingival or subgingival, according to whether it is located on the visible part of the tooth or on that part situated in the gingival pocket. Although the subgingival form may sometimes become secondarily supragingival as a result of surgical operations, such as gingivectomy, or in response to retraction of the gingiva, it is not difficult to distinguish between the two forms. In most cases there are marked differences in appearance, consistency, and attachment.

Supragingival calculus is usually less hard and less firmly attached to the surface of the tooth. It is mostly white or yellowish. Occasionally, it forms a voluminous coating and appears most readily where the ducts of the large salivary glands issue into the oral cavity. It is therefore to be found largely on the buccal surfaces of the two anterior upper molars and the lingual aspects of the lower incisors. *Subgingival calculus* is often hard and so firmly attached to the tooth that its removal presents a considerable problem. It is usually gray or dark in color. The deposits are not large, and they have no tendency to localization at the exits of the salivary ducts.

Other classifications of dental calculus have been made. Berke[5] distinguishes between three types: coronal, cemental, and inflammatory. Such a system, based on both location and etiology, leaves much to be desired from the aspect of lucidity. Greene[11] finds three morphologic types of subgingival calculus, one of which he attributes to bad technique in removal of former calculus.

FORMATION

Most authors agree that the inorganic constituents of dental calculus are precipitated from the saliva. The mechanism of this process is still obscure,

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however, and several theories have been advanced, the three most important, according to Hodge and Leung,[13] being the following:

Bacteriologic Precipitation.—Microorganisms, such as *Leptotrichia* and *Actinomyces,* break down salivary proteins and thus produce an alkaline environment, so that calcium salts are precipitated. Bartels[2] maintains that ammonia is formed and reacts with magnesium and phosphorus, which are present as salts in the saliva, to form the double salt ammonium magnesium phosphate.

Enzymatic Precipitation.—Phosphatase, which Adamson[1] has shown to be present in the human gingiva, is liberated from the tissue. This, in turn, liberates phosphate ions by breaking down the organic phosphates in the saliva.

Physiochemical Precipitation.—The liberation of carbon dioxide from the saliva or the formation of ammonia raises the pH of the saliva, so that calcium and phosphate salts are precipitated. Changes in the surface tension and colloidal properties of the saliva may also contribute to the formation of dental calculus. This theory is in some respects identical with that of bacteriologic precipitation.

In connection with the formation of dental calculus, Heinemann[12] points out that tissue degeneration can be followed by calcification. Accordingly, the incipient stage of dental calculus formation might be considered as calcification in a degenerated gingiva. After destruction of the gingiva, the precipitated calcium salts would be deposited as calculus on the surface of the tooth. This theory is contradicted, however, by the fact that there is always a zone of cementum in the immediate vicinity of the gingival attachment where there is no calculus at all.[3, 11]

COMPOSITION

Dental calculus consists of an organic part and an inorganic part. According to the majority of workers, the former includes microorganisms from the flora of the mouth, principally *Actinomyces* and *Leptotrichia.* Berke[5] and Yardeni[24] have found epithelial cells, and Berke also has found phagocytes in dental calculus. Mathis[19] considers that the organic medium in calculus consists of a coagulate formed from stagnating saliva.

The identification of the inorganic part has presented great difficulties, but the introduction of x-ray crystallography has considerably facilitated research in this field.

Using this technique, Philipp[21] and Mathis[18] examined a number of concrements and found three calcium phosphates, namely basic calcium phosphate or apatite, $Ca_{10}(PO_4)_2 \cdot (OH)_2$, acid calcium phosphate or brushite, $CaHPO_4 \cdot 2H_2O$, and a tricalcium phosphate, β-$Ca_3(PO_4)_2$, which proved to be identical with the mineral whitlockite. Brandenberger and Schinz[7] found apatite in dental calculus obtained from a patient.

A thorough investigation of the inorganic constituents of dental calculus has been made by Jensen and associates.[14-16] In 1954 Jensen and Danø[14] examined fifty-two specimens of dental calculus by a powder diffraction technique

and found apatite in all of them. Whitlockite was also found in 80 per cent, and in seven specimens (all from lower incisors) brushite was detected. The proportions of apatite and whitlockite were found by comparison with powder diagrams from known samples. In 1957 Jensen and Rowles[16] showed that whitlockite in dental calculus was not pure tricalcium phosphate. By measuring the shrinkage of the crystal axes, they found that one or two of the twenty-one calcium atoms in the unit cell of β-tricalcium phosphate were replaced by magnesium. In the same year Jensen and Hansen[15] reported finding a fourth calcium phosphate, $Ca_4H(PO_4)_3 \cdot 3H_2O$, which they detected in small quantities in forty-eight of 124 samples of calculus by a refined x-ray crystallographic method.

A number of investigations have been concerned with the manner in which the precipitated inorganic salts are linked in the deposition of calculus on the tooth and with how the deposit is attached to the dental surface. Most workers[5, 6, 8, 10, 20, 23] consider that the microorganisms act as a cohesive factor in the formation of dental calculus. They occur in the form of filamental fibrils, disposed perpendicularly or fairly irregularly in the deposit. Various forms of attachment to the tooth surface have been suggested. Cuticula dentis or its continuation on the cementum surface, the secondary cuticle, can affect the attachment.[22,25] Dental calculus can be mechanically attached by irregularities in the surface of the tooth.[23, 25] It has also been suggested that microorganisms in the calculus can penetrate a short distance into the cementum, and in this way fix the deposit to the cementum surface.[25]

ORIGINAL INVESTIGATION

Material and Method.—Samples of dental calculus from twenty-seven patients were examined by microradiography and analyzed by x-ray crystallography. The dental calculus was of the supragingival type in fifteen cases and of the subgingival variety in twelve. In this classification attention was paid only to location in relation to the free gingival margin.

In practically all cases the supragingival calculus was situated on the anatomic crown of the tooth, deposits on the root being present in only two instances in which the gingival margin was retracted, thus exposing a part of the root surface.

Each sample of concrement was divided into two parts—one for microradiographic examination and the other for mineralogic analysis. The first part was imbedded in methyl methacrylate, and after polymerization thin slices were cut and ground to 50 and 100 microns. The sections were exposed to nickel-filtered copper radiation at suitable power in direct contact with a fine-grained high-resolution x-ray plate. The microradiograms so obtained were enlarged. This method permitted the degree of mineralization in various parts of the specimen to be studied by virtue of the differences in x-ray absorption. A survey of various microradiographic methods has been presented by Engström,[9] and Bergman[4] has given an account of the application of the technique in the field of dental research.

TABLE I

CONSTITUENT	TYPE OF DENTAL CALCULUS	
	SUBGINGIVAL	SUPRAGINGIVAL
Pure apatite	3	4
Predominantly apatite plus small quantity of whitlockite	7	8
Predominantly whitlockite plus small quantity of apatite	2	1
Predominantly apatite plus small quantity of brushite		1
Predominantly brushite plus small quantities of whitlockite and apatite		1
Total	12	15

The chemical composition of the inorganic components of the samples was determined by means of the powder diffraction technique, which has been used by Lagergren[17] in the study of concrements of the urinary tract. Parts of the samples were pulverized and inserted in thin glass capillaries. These were exposed to monochromatic x-rays (CuKα = 1.54 Å), in a Debye—Scherrer camera, with a diameter of 114.6 mm. The powder diagrams so obtained were evaluated against reference mixtures. The proportions of the constituents were found by comparison with reference series.

Fig. 1.—Cross section through a root of a lower molar. Several deposits of calculus of the subgingival type are seen on the surface of the tooth. (Magnification, ×9; reduced 9/10.)

The results of the x-ray crystallographic analyses are given in Table I, which shows the chemical composition of dental calculus from twenty-seven patients analyzed by the powder diffraction technique.

In both cases in which the dental calculus contained brushite the material was obtained from the lower incisor segment.

Microradiographic Examination.—In all the cases of supragingival calculus the deposits were continuous. On the other hand, the subgingival calculus occurred often as discrete deposits (Fig. 1).

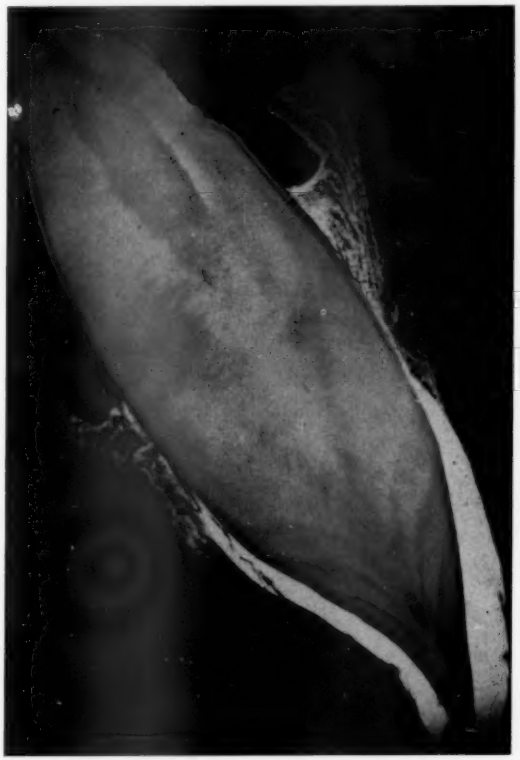

Fig. 2.—Supragingival calculus. The deposit, which is clearly stratified in parts, is situated mainly on the surface of the root. (Magnification, ×9; reduced 9/10.)

In the supragingival calculus there were, with few exceptions, larger quantities of nonmineralized substance than in the subgingival type. In five cases there was a definite stratification in the concrement (Figs. 2 and 3), with alternate layers of nonmineralized and mineralized substance. The layers were fairly parallel to the surface of the calculus deposit. In some instances there were large deposits of nonmineralized substance in the concrement (Fig. 3).

In most cases the subgingival calculus was more homogeneously mineralized than the supragingival type. In degree of mineralization, it was intermediate between dentine and enamel. Here, too, there was occasionally evidence of

stratification, although this was never so marked as in the supragingival specimens. Deposit of filamental substance in the concrement was not infrequent. Then the fibers were largely perpendicular to the surface of the tooth (Fig. 4).

Two of the samples of supragingival calculus presented a microradiographic picture that was typical of the subgingival calculus, as already described. In both cases the deposit was located at the border between the crown and the root (Fig. 5).

Fig. 3.—Stratified supragingival calculus. The part in contact with the surface of the tooth closely resembles the subgingival type of calculus. (Magnification, ×21; reduced 9/10.)

In two voluminous supragingival concrements there were parts near the dental surface which had the same microradiographic appearance as the subgingival type (Figs. 2 and 3).

In some cases of subgingival calculus the surface of the tooth on which the deposit was found was uneven, with pits and hollows. Occasionally, areas with a high degree of mineralization were observed locally in the dental substance beneath calculus deposits (Figs. 6 and 7). These zones sometimes proved to be much more highly mineralized than the corresponding concrement. In the crevices that often appeared in the ground sections, the basal cleft nearly always passed

Fig. 4.—Subgingival calculus with filiform substance included. There is a suggestion of stratification in the right part of the concrement. The tooth surface beneath the calculus is uneven. (Magnification, ×100; reduced 3/10.)

Fig. 5.—Supragingival calculus deposited at the border between the crown and the root. It resembles subgingival calculus from the aspect of mineralization. (Magnification, ×9.5; reduced 3/10.)

Fig. 6.

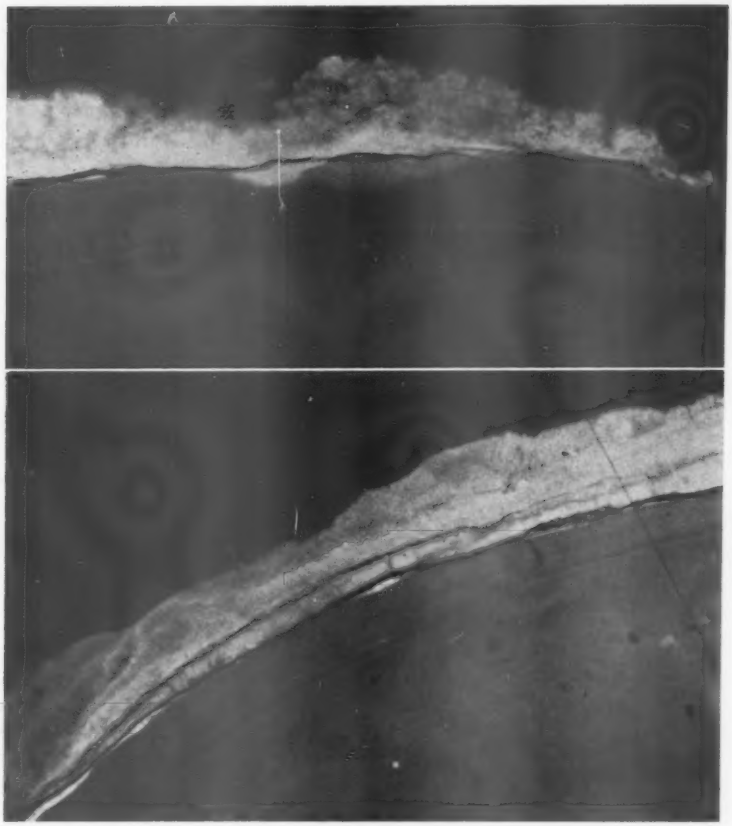

Fig. 7.

Fig. 6.—Subgingival calculus with zones of hypermineralization in the underlying tooth substance. (Magnification, ×110; reduced 3/10.)

Fig. 7.—Subgingival calculus with zones of hypermineralization in the underlying tooth substance. (Magnification, ×105; reduced 3/10.)

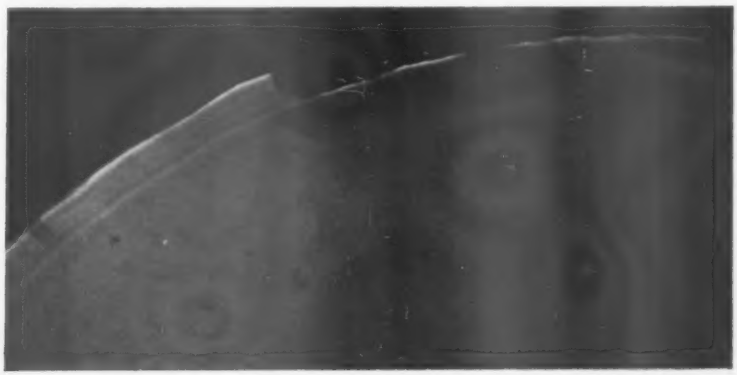

Fig. 8.—Section through a root. Within the superficial part of the tooth there is a narrow zone of hypermineralization. (Magnification, ×10.5; reduced 3/10.)

between the concrement and the zone of hypermineralization. In two cases there was a narrow marginal zone of high x-ray absorption on the surface of the tooth beside the concrement (Fig. 8). Such zones can occur as a photographic artifact at the border between zones of very high and very low absorption. In these two cases it appeared to be a highly mineralized marginal zone, since a similar phenomenon was observed on the microradiograms where there was no question of an artifact (Figs. 6 and 7).

DISCUSSION

Microradiographic examination revealed a distinct structural difference in most cases between the supragingival and subgingival calculus. In the former type of deposit there were more nonmineralized areas. Occasionally, moreover, there was a clear stratification, with alternating mineralized and nonmineralized layers. The reason for this phenomenon is unknown.

In two cases the structure of the supragingival calculus had the same appearance as that of the subgingival specimens, and in two other cases the supragingival calculus contained a basal layer of the type found in subgingival calculus. The number of observations was too small for conclusions to be drawn, but it is justifiable to assume that the structure of the dental calculus is dependent on factors other than those associated with location in relation to the gingival margin.

One interesting observation was the occurrence of local zones of hypermineralization in the dental substance immediately beneath the concrement. This impression was supported by the results of a supplementary examination. It would seem that the process responsible for the formation of the calculus, at least in places, penetrates into the superficial tooth substance, as Zander[25] has supposed. A practical consequence of this would be that removal of the calculus must include planing of the surface of the tooth.

On practically all the specimens of both series there was a narrow, dark line between the tooth and the deposit. This might be either a crevice or an unmineralized membrane which attaches the calculus to the tooth surface. In a few cases it was clearly a crevice, but this finding is not incompatible with the presence of a membrane in other cases. Zander[25] and Shroff[22] maintain that the cuticula dentis and the secondary cuticle occupy such a position between the calculus and the tooth.

SUMMARY

Samples of dental calculus from twenty-seven patients were examined microradiographically and analyzed by x-ray crytallography. The location of the deposit was supragingival in fifteen cases and subgingival in twelve.

Chemical analysis of concrements revealed that the calculus of both types consisted, in the majority of cases, of apatite with small amounts of whitlockite and that about half as many specimens consisted of pure apatite.

Microradiography revealed that in most cases there was a larger amount of nonmineralized substance in the supragingival type than the subgingival

type. In five cases there was definite stratification in the supragingival calculus, with nonmineralized material alternating with mineralized.

In two specimens of supragingival calculus the concrement presented the microradiographic picture typical of subgingival specimens. In two cases of voluminous supragingival calculus there were areas of a subgingival nature in the region adjacent to the tooth surface.

In some cases zones of hypermineralization were found in the tooth substance immediately below the concrement. In two cases there was also a narrow, highly mineralized marginal zone on the tooth surface beside the concrement.

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ORAL MEDICINE

A COLOR SHADE CHART FOR STUDY OF THE ORAL MUCOUS MEMBRANES: PREPARATION AND CONSTRUCTION

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ALTHOUGH in the past the color of the soft tissues of the mouth has been used as a prime diagnostic criterion in the study of various oral mucous membrane lesions, relatively few attempts have been made to quantify the color of the normal oral mucous membranes or the colors which might be termed pathognomonic of various oral disease entities.

The initial phase of our present study was concerned with the preparation of a series of finely graded oil-painted color chips which might be used to standardize the reporting of colors as observed in tissues of the oral mucosa.

The technique of preparation and the characteristics of the shade guide are the subject matter of this presentation. Subsequent reports will deal with the application of the color shade guide to the study of the oral mucous membranes in normal patients and in patients with various oral mucous membrane diseases and with the use of this guide in evaluating the response of lesions of the oral mucous membranes to various therapeutic agents.

THE COLUMBIA COLOR SHADE CHART

The Problem.—The problem presented to one of us (H. P.) was the preparation of a color chart composed of loose tabs which would approximate any tint that might occur in the mucous membranes of the oral cavity. These tabs were to be made from color pigments which were as permanent as possible, and they were to be tough enough to withstand cold sterilization and the abuses of constant use.

Color Standards and the Selection of the Basic Red Colors.—Cadmium red (deep), in tube paints, was selected as most closely matching freshly obtained blood. When cadmium red (deep) is purchased in tubes, the pigment is usually preground in a "vehicle" (in this case, linseed oil, to which a small percentage

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of a stabilizing agent, such as aluminum stearate, is added). There may also be varying amounts of inactive "fillers."

In addition, cadmium red (deep) was obtained in powder pigment form and was ground with (1) linseed oil, (2) poppy oil, and (3) castor oil. Samples of all these pigments were applied to standard microscope slides. Additional tabs were prepared with cadmium yellow.

Coatings.—When the paint samples were sufficiently set, they were coated with a clear flexible plastic (Tygon). Three dippings (allowing at least twenty-four hours for the hardening of each dipping) were found sufficient. An attempt to mix the powder pigment with Tygon proved awkward.

This coating was considered necessary (1) to protect the paint against dirt and handling, (2) to provide a means of keeping the color moist in appearance, (3) to provide a surface which was easily cleaned and could withstand a variety of antiseptics, and (4) to protect the color from airborne chemicals.

Permanence.—Oil colors are not guaranteed with respect to absolute permanency of the more brilliant reds. It was necessary, therefore, to undertake permanency checks approximating the conditions ultimately to be encountered.

The chips were placed in a north window for fifteen months (including two summers), where they received some direct sunlight during the summer months but only a constant strong half-light for the remainder of the period. At the end of this time, comparison of the above-described, light-exposed red chips with fresh pigments proved Winsor and Newton tube color and powder pigment in poppy oil to be the most acceptable. Winsor and Newton tube colors were ultimately chosen because of their over-all uniformity.

It was also observed that the glass tabs were relatively inadequate, owing to chipping. A more practicable material was found in D'Arches handmade, cold-pressed, 300 pound water color paper, which is flexible, tough, durable, and unchanging in whiteness. In all further work this base was used.

Selection of Other Colors.—Winsor and Newton tube colors were also selected for the yellow tints, which were to be prepared from cadmium yellows (deep, medium, and pale) and for the blue tints, which were to be prepared from ultramarine blue (deep). To achieve the two darkest red shades, cadmium red (deep) with barium, as manufactured by Permanent Pigments, was chosen. For the brownish series, the Rembrandt oil color (Talens and Son, Holland), Mars Yellow, which is generally accepted as an absolutely permanent color, was used.

For white, Weber's Permalba was obtained as the result of personal experience. Lead whites tend to turn yellow when not exposed to sunlight. Titanium white has "body" but eventually turns gray. Zinc white is permanent in whiteness but is too transparent. Permalba, although a comparatively recent development, has rapidly become a favored pigment among artists because of its opacity, its apparent resistance to change, and its ability to blend smoothly with colors.

Physical Design of the Guide.—A general color chart was thus ultimately prepared, with component chips ranging across the top from red with deep ultramarine blue, through pure cadmium red (deep) to red with cadmium yellow (deep), and shading downward in all these series from red to white (Table I).

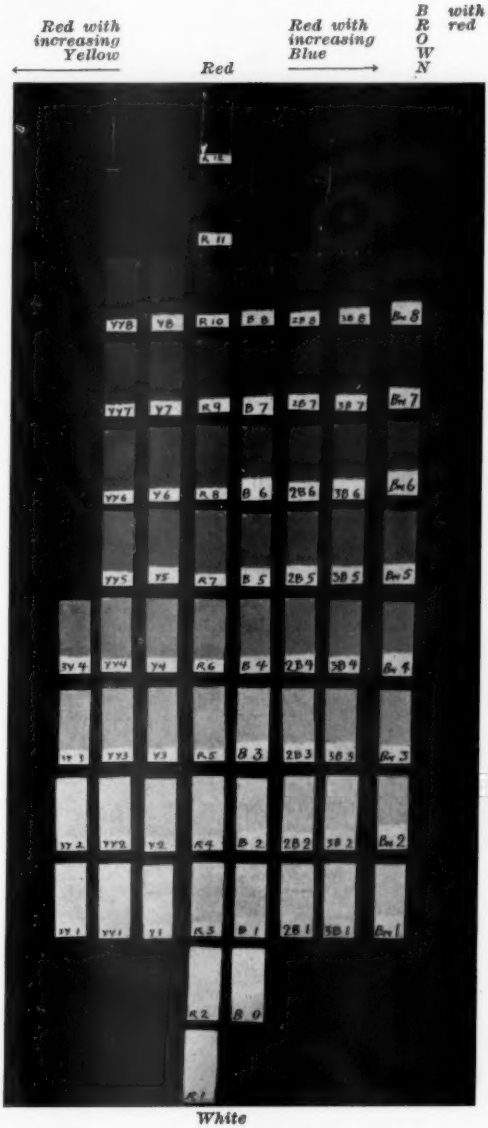

Fig. 1.—Photograph of the sixty-five color chips included in the color shade guide.

Preliminary clinical testing of the color chips indicated the need for additional colors which were thereafter created until the ultimate chart of color chips was completed. A tan-influenced category was added still later, bringing the total number of chips available for use to sixty five (Fig. 1).

The color shade guide* described in this report is not yet available for general or even limited large-scale distribution.

TABLE I. COLORS EMPLOYED IN PREPARATION OF CHIPS COMPRISING THE COLOR SHADE GUIDE

White	—Permalba (trade name)
R1 through R9	—Mixture Permalba and cadmium red (deep)
R10	—Cadmium red (deep)
R11	—Cadmium red (deep) and cadmium-barium red (deep)
R12	—Cadmium-barium red (deep)
Y1	—R3, cadmium yellow (pale), and white
Y2	—R4, cadmium yellow (pale), and white
Y3	—R5, cadmium yellow (pale), and white
Y4	—R6, cadmium yellow (pale)
Y5	—R7, cadmium yellow (pale), and cadmium yellow (medium)
Y6	—R8 and cadmium yellow (medium)
Y7	—R9, cadmium yellow (medium), and cadmium yellow (deep)
Y8	—R10 and cadmium yellow (deep)
YY1-8	—As in Y1-8, but with higher percentage of the yellows
3Y1-4	—As in YY1-4, but with higher percentage of the yellows
4Y3	—As in 3Y3
BN1-7	—R3-9, with Mars Yellow, and white
BN8	—R10 with Mars Yellow
B1-8	—R3-10 with ultramarine blue (deep), and white
2B1-8	—As in B1-8, but with higher percentage of the ultramarine blue
3B1-8	—As in 2B1-8, but with higher percentage of the ultramarine blue

DISCUSSION

It is felt that the color shade guide reported might be found useful to (1) standardize normal color values (obtaining their means and extremes) of the oral mucous membranes in various sites, (2) evaluate the colors observed in various oral soft-tissue diseases (including quantitative evaluation as to severity of disease), (3) quantitatively evaluate response to therapy, (4) serve as a diagnostic tool, and (5) establish various color characteristics of tissues as keratinization, pigmentation, etc.

SUMMARY

A color shade chart composed of sixty-five color chips for study of the oral mucous membranes is described. The possible uses of such a color shade guide are considered.

The authors are indebted to Mrs. Helene W. Kutscher for her assistance.

630 WEST 168TH ST.

*All supplies described are readily available through art supply stores.

THE TREATMENT OF PRECANCEROUS ORAL MUCOUS MEMBRANES

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IN GENERAL cancer control, prophylaxis has been one of the least investigated of therapeutic measures. In oral cancer, however, definite studies are showing that certain precancerous conditions can be returned to normal by a simple regimen which includes the use of a crude substance, the active properties of which are yet to be identified.

DESCRIPTION OF PROJECT

An experimental group of 120 patients, all with subjective complaints referable to the oral mucous membranes, was selected. Atrophic and degenerative changes in the oral mucosa were observed in all of these patients. In addition, other precancerous conditions, such as leukoplakia, extensive superficial scarring, erosions, chronic inflammation, vascular injection, and even superficial ulcerations, were frequently noted. However, the basic and probably the initial change was atrophy, with the other precancerous states superimposed upon it. This was due, in all probability, to the decreased ability of the abnormal mucosa to withstand average oral irritations.

Thirty-four of the patients were found to share an added complaint which was causing great mental and physical discomfort, namely, they were unable to tolerate their dentures full time. In order to initiate this study and to make it as specific as possible, these patients were selected for a separate test of the therapeutic effectiveness, both subjective and objective, of the various medications.[6] The remaining eighty-six patients demonstrated precancerous mucous membranes with primary oral lesions as follows: Chronic inflammation was seen in thirty-eight, atrophy in twenty-two, leukoplakia in fourteen, erosions in eight, and superficial ulcerations in four. Both groups were studied with equal care and were given the same medications.

The symptoms of all patients with the low denture-tolerance syndrome were described as soreness, rawness, burning, and dryness, primarily of mucous membranes in contact with the dentures or teeth. However, most of the patients also experienced the same symptoms to a lesser degree throughout the oral cavity. The mucosal surfaces most commonly involved were the sides of the

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tongue, the buccal areas, and (less frequently) the gingival and palatal surfaces. Most patients with histories of long irritation showed involvement of the pharynx with the same symptom complex.

Women with a prolonged history compained also of dryness and irritation of the eyelids (keratoconjunctivitis sicca) and similar symptoms in the vagina. "Indigestion" was a frequent associated complaint. The majority of the patients were in the sixth and seventh decades of life and gave long histories of gastrointestinal distress.

In a previous article[4] the relationship of achlorhydria to atrophic and hypersensitive mucous membranes was reported. In the group of thirty-four denture cases, fifteen patients (or approximately 50 per cent) were found to have a complete lack of gastric hydrochloric acid secretion, as compared with an average of 32 per cent in the general population of the same age group. This again suggests an abnormal state of the mucosal surfaces throughout the body.

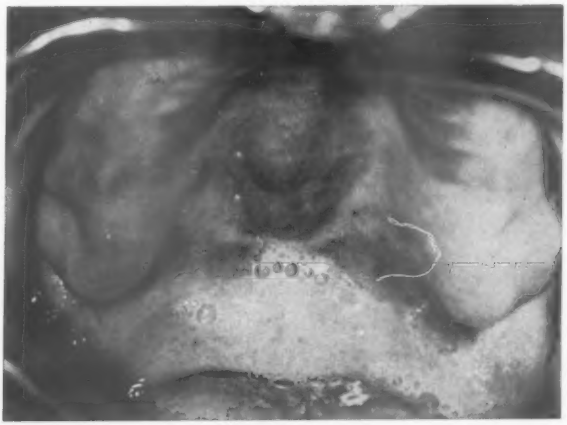

Fig. 1.—Low denture-tolerance case with atrophic mucous membrane and an inflammatory response.

PATHOLOGY

The basic signs of abnormal mucous membranes are atrophy and inflammation.[7] In these patients the mucosa on the buccal surfaces and sides of the tongue appeared abnormally smooth, with a loss of the normal linear markings. The filiform papillae of the tongue were either atrophic or absent, but only rarely was the tongue typically "bald." The mucous membranes appeared erythematous due to hyperemia, and the increased transparency was secondary to the atrophy. In advanced cases, there was marked vascular injection of the mucous membranes in contact with the dentures. The membranes were tender and painful, and superficial ulcerations were generally present where irritation was greatest. This was usually observed along the lateral margins of the tongue and on the gingival or buccal surfaces.

Leukoplakia has been accepted as the most frequent precancerous lesion in the mouth. It has been previously reported,[5] however, that atrophic mucosal changes are more common and that the leukoplakia is usually a response of this type of mucosa. This is an effort on the part of the degenerative mucous membrane to protect itself against oral irritations.

ETIOLOGY

A definite relationship between oral mucosal atrophy and dietary deficiency has long been recognized. Manson[1] first introduced this concept many years ago in his treatise on sprue. Many deficiency diseases became known long before the isolation of specific vitamins. One of the first was rickets, in which it was found that the oral manifestations were caused by the absence of vitamin D in the diet. Later, raw liver was shown to reverse the abnormal changes in pernicious anemia, including changes in the oral mucous membranes.

Fig. 2.—Long-standing atrophic buccal mucosa with extensive superficial scarring and inflammation.

Spies[8] stated: "The body processes are so integrated, so dependent upon an adequate supply of essential chemical substances contained in foods, that an absence or deficiency of any one important factor may impair the effciency of the whole chain of reactions." This is demonstrated by the many and varied signs and symptoms present in the vitamin-deficiency syndromes. Since the isolation of crystalline vitamin products, specific therapy has been available for specific syndromes. Very seldom, however, does one see a deficiency syndrome characterized by the absence of one vitamin alone. As a rule, numerous deficiencies in various vitamins and nutritive substances exist simultaneously.

Martin and Koop[2] have emphasized that, as a rule, patients with abnormal atrophic mucous membranes give no history of a specific deficiency and that in such patients there are no physical findings of such a deficiency. He concluded

that specific vitamin therapy was therefore not possible. His findings have been borne out by this study. Only two patients in this series demonstrated a specific vitamin deficiency. Both had pernicious anemia.

It may be that patients with atrophic mucous membranes are unable to assimilate or retain a sufficient amount of nutritive substances from even the most carefully directed diets. Possibly they are unable to utilize these substances properly because of a basic metabolic defect. The usual vitamin therapy (even with all the vitamins known at present) has not reversed the degenerative mucosal changes in any appreciable number of cases.[2, 6, 7] The results of this study show that crude compounds including brewer's yeast and/or liver preparations, combined with vitamins, have been much more successful than vitamin

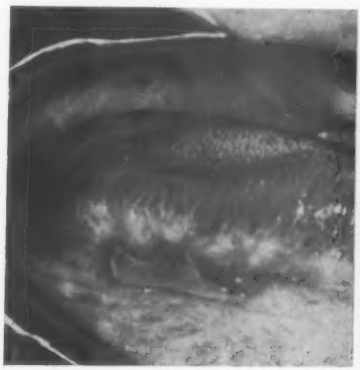

Fig. 3.

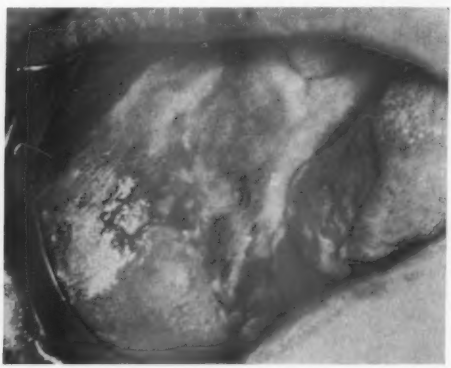

Fig. 4.

Fig. 3.—Single superficial erosion on an atrophic mucous membrane.
Fig. 4.—Superficial ulceration on buccal surface; same on opposite surface with marked atrophy of all oral mucous membranes.

therapy alone in correcting abnormal mucous membranes. This would seem to indicate that there must be unidentified fractions in crude liver and yeast which are responsible for improvement in mucous membranes and that this improved condition, in turn, increases the patient's ability to withstand average oral irritations and to tolerate dentures full time. In any event, leukoplakia as well as other precancerous states heretofore mentioned are found to be definitely associated with metabolic deficiency.

TREATMENT

General as well as local conditions must be considered in the treatment of the sore mouth. Obviously, dentures must be properly adapted, and allergy or sensitivity to denture material must be excluded. With these factors ruled out, the problem becomes more general and indicates an underlying metabolic deficiency. This might include abnormal liver function, abnormal assimilation, a basic metabolic defect of some type, or deficient intake.

In order to evaluate the problem effectively, a complete history plus a physical examination and laboratory work-up was required. The average diet in this group of patients was found to be lacking in vitamins, particularly in the B-complex group, although there were great variations. Since natural foods are the most satisfactory source of vitamins and nutrients, over-all dietary instruction was given. However, even an excellent dietary intake did not relieve the symptoms and complaints of all patients with abnormal mucous membranes. Digestive distress, which was extremely prevalent in this group of patients, called for further relief.

The achlorhydric patients were made much more comfortable by an improved form of acid supplementation.* This in itself partially relieved the symptoms of soreness in some 20 per cent of the patients. A logical explanation of this phenomenon is that the acid improves absorption of unknown vitamins or substances from an adequate diet. It is therefore believed that supplementary acid is of significant therapeutic benefit, since eight of the achlorhydric patients voluntarily continued the acid tablets along with subsequent medication.

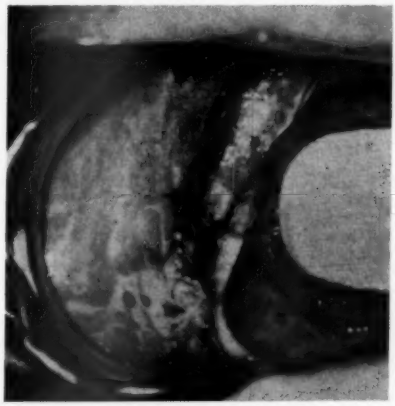

Fig. 5.—Advanced precancerous leukoplakia on abnormal atrophic mucous membranes.

As previously stated, many vitamin preparations have been used in an effort to relieve the symptomatology and improve the texture of degenerative mucous membranes. Rhoads and Miller[3] first demonstrated that the mucous membranes in many patients with oral cancer were improved symptomatically by the oral administration of dry granular brewer's yeast. Martin and Koop[2] found that beneficial mucosal effects with yeast were incontestable in patients with precancerous lesions and oral cancer, and even in control subjects, although in many patients no specific deficiency could be demonstrated.

The literature contains many additional reports concerning the relationship between atrophy of the oral mucous membranes and the state of the mucosa

*Normacid tablets (The Stuart Company, Pasadena, California).

throughout the body, as well as many different therapeutic programs. Our patients were put on a high-protein diet, but not all were able to follow this regimen. Poor appetite, digestive distress, sore mouth, and denture irritation were chiefly responsible. Therefore, vitamin supplementation in many combinations as well as marketable protein supplements, brewer's yeast, and liver were tried. The latter two were often poorly tolerated because of digestive reactions and/or complaints of their unpalatability. Occasional improvement was obtained with vitamins B_1, B_6, and B_{12} in various combinations, both orally and parenterally.

Finally, a tablet was prepared containing 750 mg. of desiccated liver, 5 mcg. of vitamin B_{12} in the form of $Ionex_{12}$, 1.5 mg. of riboflavin, and 0.5 mg. of folic acid.* Patients in the series were given three to six of these tablets daily, in addition to the dietary instructions. The fifteen achlorhydric patients were at first advised to discontinue the Normacid tablets, but after a short time (as previously mentioned) eight patients voluntarily resumed this medication because of the additional digestive comfort which it afforded.

Fig. 6.—Plummer-Vinson type of mucous membrane. Following excision of the minute carcinoma, the membranes increased their tolerance to dentures.

RESULTS

The specific study of the thirty-four selected patients with the low denture-tolerance syndrome was continued as outlined for three to six months. At the start of treatment none of these patients was able to tolerate dentures full time. Two patients had unilateral burning of the tongue (glossodynia) and showed no response to treatment. Two others were excluded because of their inability to follow directions. Within two to six weeks from the commencement of treatment, all of the remaining thirty patients were able to wear their dentures comfortably twenty-four hours a day. Six patients continued to have intermittent mild soreness and/or dryness over the oral surfaces, while the other twenty-four were completely relieved of all oral complaints within a few months.

Although it is somewhat early to make a definite statement, general improvement was noted in the other group of eighty-six patients with precancerous oral lesions. The response was less dramatic, for this group did not have

*Mucoplex tablets (Stuart Company). $Ionex_{12}$ is an absorption-enhanced form of vitamin B_{12}.

the complaint of extreme sensitivity to denture irritation. However, erosions and superficial ulcerations cleared up relatively soon (one to two months), while it took three to four months for mucosal atrophy and inflammation to disappear. Leukoderma (hyperkeratosis or preleukoplakia) and superficial leukoplakia frequently disappeared, while the advanced plaquelike leukoplakia has been showing some improvement by becoming thinner and less opaque and the frequently associated erythema and inflammation have disappeared.

Certainly, it is presumptuous to state at this time that this or any other medication will prevent squamous cancer of the oral region. However, we believe that it is definitely a step in the right direction and that, given enough time and with adequate controls, we may possibly prove this fact.

SUMMARY

An apparently successful, easily tolerated treatment has been outlined for patients with typical precancerous lesions of the oral mucous membranes. A separate objective study has been conducted in patients who had these conditions plus a low tolerance to dentures. There has been consistent objective and subjective improvement on a simple therapeutic regimen which appears to offer possibilities in the prevention of oral cancer.

This regimen included systematic regulation of the diet, with hydrochloric acid supplementation as needed and with nutritive additives in the form of a tablet of desiccated liver, vitamin B_{12}, riboflavin, and folic acid. Our preliminary study would appear to indicate the presence of as yet unidentified substances in crude liver which are responsible to a great extent for the relief of subjective oral complaints and for the objective reversal of abnormal degenerative mucous membranes to a more normal state.

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ANESTHESIOLOGY

METHOHEXITAL SODIUM ANESTHESIA FOR THE AMBULANT DENTAL PATIENT

A Clinical Appraisal

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ACCORDING to Guedel,[1] the two chief objectives of general anesthesia are the abolition of pain and the subjugation of nervous or reflex irritability. The objectives of intravenous anesthesia for the ambulant dental patient are (1) to induce unconsciousness deep enough to abate the psychic disturbances and (2) to eliminate awareness of pain. An intravenous anesthetic agent is effective for dental procedures because pain is not constant but intermittent and because complete relaxation of the musculature is neither necessary nor desirable. The depth of anesthesia is permitted to fluctuate between consciousness and unconsciousness, according to the severity of the pain stimuli of the operative procedure. The reflexes should be kept active during the course of the anesthesia, so that their protective mechanisms are functioning while the patient is asleep. The differences between this type of anesthesia and the types commonly used are far greater than is generally realized.

Methohexital sodium, a new ultrashort-acting intravenous barbiturate anesthetic, satisfies the objectives of intravenous anesthesia for the ambulant dental patient better than any of the intravenous agents that I have used to date since it has important advantages which result in increased safety for the patient.

CHEMISTRY

Methohexital differs chemically from the other ultrashort-acting barbiturates in that it is not a thiobarbiturate, since there is no sulfur in the radicals. There are two positions of unsaturation in the five-position radicals.[2] In solution, methohexital is clear and colorless and will remain stable at room temperature for at least six weeks.

PHARMACOLOGY

Compared with the thiobarbiturates, the important characteristics of methohexital are (1) greater potency, (2) shorter duration of effect, and (3) more

prompt recovery by the patient. Methohexital is two to five times as potent as the various thiobarbiturates, and it is used in a 1 per cent solution (10 mg. per cubic centimeter) compared with 2 per cent to 5 per cent solutions of the thiobarbiturates. The duration of effect of methohexital is about one-half that of the thiobarbiturates. Consequently, the patient recovers much faster with methohexital; in fact, recovery is prompt and complete following small doses. Since methohexital is more rapidly deactivated, it accumulates more slowly than the thiobarbiturates. Consequently, for cases in which anesthesia of longer duration is needed, a greater number of intermittent doses of methohexital is required to maintain the desired level of anesthesia. Nevertheless, recovery from large doses of methohexital is more rapid than from comparable doses of the thiobarbiturates, making it feasible to use methohexital in cases requiring anesthesia of longer duration.[3]

USES OF METHOHEXITAL

Methohexital is useful in several fields of dentistry, as follows:

1. *Oral surgery:* Extraction of teeth, alveolectomies, removal of impactions, and other minor oral surgical procedures.
2. *Restorative dentistry:* Cavity preparations plus restorations and crown preparations plus impressions.
3. *Periodontics:* Scaling, curettage, gingivectomy, and uncomplicated cases of osseous surgery.
4. *Endodontics:* Apicoectomy and exposure of putrescent pulp chambers in the presence of acute pain.
5. *Prosthodontics:* As a sedative for taking impressions in the intractable gagger. An average dose of 50 mg. methohexital is injected at the rate of 1 c.c. (10 mg.) per five seconds. This slow rate of injection induces the patient into a state of euphoria and amnesia, resulting in satisfactory control of the gag reflex. A rapid injection must be avoided, for it would have a soporific effect. The patient is ambulant at completion of the procedure.

PREPARATION OF PATIENTS FOR METHOHEXITAL ANESTHESIA

The patient is instructed to abstain from solid foods for four hours and from liquids for two hours prior to the appointment time. After attention has been given such personal needs as emptying of the bladder and loosening of tight-fitting clothes, the blood pressure and pulse rate are recorded, and a brief and pertinent medical history is taken. The history should include age, weight, previous illnesses and surgery (particularly during the past year), drug allergies, drugs taken within the past six months, and duration of bleeding from cuts.

Premedication is used on a selective basis, only when procedures are expected to take more than ten minutes. An average dose of 1/150 grain atropine sulfate plus 30 mg. methohexital, incorporated in the same syringe, is injected

slowly. Atropine is believed to inhibit vagal action and act as a cardiac protective mechanism[4]; it is particularly desirable for restorative dentistry, since it is an antisialogogue.

METHOHEXITAL ANESTHESIA TECHNIQUE

Age is not a contraindication to the use of an intravenous anesthetic. Methohexital is used in young children if there is an accessible and adequate vein.[5]

The Reimer technique[6] is used for children who will not submit to venipuncture. Nitrous oxide with 10 per cent oxygen is administered until a light plane of analgesia is reached, prior to the stage of excitement. A venipuncture is made instantly and 30 mg. to 50 mg. methohexital is injected at the rate of 1 c.c. per second, supplemented by the inhalation of 100 per cent oxygen for short procedures and nitrous oxide with 25 per cent oxygen for longer procedures. A smooth, light plane of anesthesia is present seconds after the injection, and the procedure is performed on a tranquil patient. In most cases, the child will awaken calm and serene, with no knowledge of the venipuncture.

Hubbell and Krogh[6-9] have developed techniques for using intravenous anesthetics in teen-agers and adults. These techniques are especially effective with methohexital.

Technique 1, methohexital and air, is used for procedures estimated to last up to ten minutes, on "A" risk patients (nothing adverse in medical history). Methohexital is the only anesthetic used, and room air is inhaled throughout the procedure.

Technique 2, methohexital and 100 per cent oxygen, is used for procedures estimated to last up to ten minutes, in aged patients, pregnant women, and patients with controlled diabetes, asthma, cardiac disease, hypertension, and hypotension. Methohexital is the only anesthetic used, and 100 per cent oxygen is administered throughout the procedure.

Technique 3, methohexital with nitrous oxide and oxygen, is used for longer procedures. Nitrous oxide with 15 per cent to 50 per cent oxygen is administered after induction of anesthesia with methohexital.

The inductions are similar in the three techniques. The venipuncture is made and the glass cannula or observation tube is taped to the arm (the Hubbell injector is preferred).[6] The needle remains in the vein during anesthesia and until the patient responds to verbal instructions after completion of the procedure.

The induction dose of methohexital is determined by the estimated duration of the procedure and an evaluation of the patient's general health and vitality (based upon sex, age, weight, blood pressure, and pulse rate). The induction dose can be estimated correctly with proper evaluation of the patient, and a so-called test dose is seldom necessary.

In the first technique the induction dose varies from 50 to 150 mg. methohexital, the intermittent doses vary from 10 to 70 mg., and the rate of injection

is 1 c.c. per second. If the induction dose has been estimated correctly, the patient passes in rapid succession into euphoria, amnesia, and finally a light plane of anesthesia, which is reached in ten to twelve seconds. The operative procedure begins at this precise moment. A short procedure, such as the extraction of one or two teeth, can be completed with a single injection of methohexital. If the patient shows signs of objecting (stiffening, moving, or twitching of the face), however, the procedure is halted and another increment of methohexital is injected. The procedure is resumed as soon as the drug takes effect. This phase should take no more than twenty seconds. The intermittent doses are determined on an individual basis.

The following three hypothetical cases illustrate induction doses.

(1) Female, age 20, weight 100 pounds, blood pressure 110/70, pulse rate 72; induction dose, 50 mg.

(2) Male, age 25, weight 150 pounds, blood pressure 120/80, pulse rate 80; induction dose, 100 mg.

(3) Male, age 30, weight 200 pounds, blood pressure 140/80, pulse rate 90; induction dose, 150 mg.

In the second technique the administration of 100 per cent oxygen for two minutes precedes a 30 to 50 mg. dose of methohexital, injected at the rate of 1 c.c per two seconds. Additional increments of 10 to 30 mg. are injected as needed, and 100 per cent oxygen is administered throughout the procedure.

Although a period of inanition is essential for general anesthesia, one exception has been made possible with the second technique. Emergency cases in which the extraction of one or two teeth is required are accepted even though the stomach is not empty. Barbiturates do not stimulate the vomiting center, and with this technique hypoxia, which may stimulate the vomiting center, is avoided. Thus, nausea and vomiting have not been experienced in these cases.

In the third technique nitrous oxide with 25 per cent oxygen is administered after induction with methohexital. The blow-off valve of the nosepiece is kept open to avoid an accummulation of carbon dioxide. A mouth pack is used (never a throat pack). It may be necessary at times to reduce the oxygen supply to as low as 15 per cent because of mouth-breathing. Increments of 10 to 70 mg. methohexital are given during the operative procedure, which usually lasts from fifteen minutes to one hour. A limit of two hours is recommended for early ambulation.

The differences in patients' attitudes, temperaments, and types of operative procedures at times require combinations or modifications of the anesthesia techniques to (1) save time, (2) increase efficiency, and (3) serve the patient's needs.

A patient who is evaluated as an "A" risk but appears apprehensive and pale should be ventilated with 100 per cent oxygen for two minutes before the venipuncture.

Techniques 1 and 3 are used interchangeably for a surgical procedure involving the labial and buccal areas of the maxillary arch. Technique 1 is

used to give the operator full access to the labial area, and technique 3 is used for surgery in the buccal area.

Occasionally, a child will request "the needle in the arm." This patient is ventilated with 100 per cent oxygen for two minutes, 30 to 50 mg. methohexital is injected, 100 per cent oxygen is continued for the short procedures, and nitrous oxide with 25 per cent oxygen is administered for the longer procedures. However, should this type of patient object to the application of the nosepiece, 20 mg. methohexital is injected slowly to induce sedation and amnesia, the nosepiece is then applied, 100 per cent oxygen is administered, another small increment of methohexital is injected, and either 100 per cent oxygen is continued or nitrous oxide and oxygen is administered.

SIDE EFFECTS OF METHOHEXITAL

Induction.—As soon as the induction dose takes effect, there is an increased respiratory effort of two or three seconds' duration.

Maintenance.—Coughing and jactitations lasting a few seconds and hiccupping that lasts from seconds to minutes may occur. These side effects are of no clinical significance, except that they may be annoying to the operator because of the resultant head movements. On occasion, a patient will start to "crow," indicating some interference with respiration. The operative procedure is immediately halted, and the difficulty is corrected.

Recovery.—Headaches, laughing, crying, chills, and tremors occur occasionally.

The side effects are of minor consideration since they occur infrequently, as shown in Table I. In most cases the entire procedure is uneventful and

TABLE I. STUDY OF FIFTY PATIENTS, RECORDING TOTAL DOSAGE OF METHOHEXITAL, ANESTHESIA TECHNIQUE, DURATION OF ANESTHESIA AND SIDE EFFECTS

1. Total dosage range—30 mg. to 320 mg.		
2. Technique	No. patients	
100 per cent O_2-methohexital	4	
100 per cent O_2-methohexital-N_2O-O_2	4	
Methohexital—N_2O-O_2	8	
Reimer	1	
Methohexital—air	33	
Total	50	
3. Duration of anesthesia range—3 to 75 minutes		
4. Side effects	No. patients	
Crying	3	
Chills and tremors	2	
Coughing	2	
Laughing	1	
Jactitations	3	
Hiccups	3	
Salivation	1	
Headache	2	
Total	17	
Total types of side effects		8
Total number of side effects		17
Total patients with side effects		15
Total patients with no side effects		35

(*Note:* One patient had three different side effects)

gratifying to all concerned. The patient awakens euphoric and amnesic; in many instances he doubts that he has been asleep and that the operative procedure has been completed.

EFFECTS ON RESPIRATION, BLOOD PRESSURE, AND PULSE RATE

Respiration.—The reactions to an induction dose of methohexital are as follows: An increased respiratory effort of two or three seconds' duration occurs ten to twelve seconds after injection. Rhythmic respiration follows, with little reduction in amplitude, which makes monitoring of the breath sounds an easy task.

Blood Pressure.—In Table II, a study of twenty patients shows that the blood pressure in the postoperative period is generally the same as during the preoperative state. In Table III a more detailed study of the blood pressure of ten patients reveals changes in both systolic and diastolic pressures after induction, during maintenance, and upon recovery. The highest change recorded is 25 mm. Hg. These fluctuations are of no clinical significance, except as they may affect the dosage of methohexital. A rise in blood pressure increases the metabolic rate and may require additional methohexital; a fall in blood pressure has the opposite effect.

Pulse Rate.—In Table II, a study of twenty patients shows that the pulse rate in the postoperative period is generally the same as in the preoperative state. The changes are slight, except in one case in which the pulse rate increased 28 points along with a similar rise in blood pressure. An increased pulse rate indicates increased nervous irritability and may require additional methohexital; a slowing of the pulse rate has the opposite effect.

The causes of the blood pressure and pulse rate changes are not clear to me. Further study of this subject is necessary.

SUMMARY OF ADVANTAGES AND DISADVANTAGES OF METHOHEXITAL

Methohexital offers the following advantages, most of which mean greater safety for the patient:

1. Economy: The drug is more stable in aqueous solution, obviating the need for discarding because of deterioration; refrigeration is neither necessary nor desirable.
2. Methohexital is tasteless and odorless during induction.
3. There is a shorter duration of action or effect as well as shorter recovery time and less postoperative amnesia.
4. There is less cumulative effect and more rapid orientation. There is no inebriation or diplopia from small doses and very little from large doses. Longer cases are more feasible.
5. Skeletal-muscle relaxants are not needed for the athletic or alcoholic patient.
6. There is less respiratory depression and more amplitude during maintenance. It is easier to monitor the breath sounds.

TABLE II. DETAILED STUDY OF TWENTY PATIENTS, WITH RECORDINGS AND TABULATIONS

PATIENT NO.	SEX	AGE	WEIGHT	PREOPERATIVE BLOOD PRESSURE	POSTOPERATIVE BLOOD PRESSURE	PREOPERATIVE PULSE RATE	POSTOPERATIVE PULSE RATE	OPERATIVE PROCEDURE	TOTAL METHOHEXITAL DOSAGE (MG.)	DURATION OF ANESTHESIA (MINUTES)	AMBULATION TIME (MINUTES)
1	F	35	145	130/85	130/85	84	80	1 X	70	4	15
2	M	21	135	120/80	120/80	96	96	1 X	80	3	10
3	F	18	145	100/60	100/60	64	64	1 X	50	5	25
4	M	56	160	160/90	160/90	116	116	6 X	420	25	60
5	F	27	190	150/110	140/100	88	86	3 X	270	10	20
6	F	22	100	120/70	120/70	80	80	3 X	130	5	20
7	M	40	185	100/80	100/80	76	76	1 X	100	3	15
8	M	65	155	140/90	140/90	104	104	3 X	250	10	25
9	M	17	140	105/60	105/60	76	76	6 X	250	10	60
10	M	36	155	120/80	120/80	88	88	1 X	80	3	10
11	M	19	155	130/80	130/70	76	76	1 X	70	3	20
12	F	46	175	140/80	135/80	88	84	3 X	130	5	20
13	F	33	138	130/85	160/90	88	116	4 X	250	10	25
14	F	22	134	120/80	120/80	88	88	10 X-alveolo.	380	55	85
15	M	62	210	160/80	150/80	120	120	17 X-alveolo.	600	45	75
16	F	19	160	115/80	115/80	88	88	X – imp. $\lfloor 3$	360	75	150
17	F	22	97	115/70	120/70	110	110	X – U $8\,\vert\,8$ X – imp. $\overline{8\,\vert\,8}$	240	35	95
18	F	18	156	120/70	120/70	128	124	Rest. dent. for 8 teeth	410	80	150

(Continued on opposite page.)

TABLE II—CONT'D

PATIENT NO.	SEX	AGE	WEIGHT	PREOPERATIVE BLOOD PRESSURE	POSTOPERATIVE BLOOD PRESSURE	PREOPERATIVE PULSE RATE	POSTOPERATIVE PULSE RATE	OPERATIVE PROCEDURE	TOTAL METHOHEXITAL DOSAGE (MG.)	DURATION OF ANESTHESIA (MINUTES)	AMBULATION TIME (MINUTES)
19	F	18	160	120/70	120/70	110	110	Rest. dent. for 1 tooth Cr. prep. + imp. 1 tooth	350	60	120
20	F	40	135	120/80	120/80	80	80	Rest. dent. for 5 teeth Extensive scaling Gingivectomy, lower anterior	380	120	300

X = Removal of tooth.
U = Unerupted.
Imp. = Impaction.
Alveolo. = Alveolectomy(mies).
Rest. dent. = Restorative dentistry.
Cr. prep. + imp. = Crown preparation and impressions.
Duration of anesthesia: From time of induction to patient's response to vocal instruction after completion of procedure.
Ambulation time: From time of induction to dismissal of patient. (Patients are usually permitted to awaken without being roused.)

Tabulations

Sex: 12 females, 8 males
Age range: 17 to 65 years
Weight range: 100 to 210 pounds

Blood pressure

Unchanged	14 patients
Fall	5
Rise	1
Total	20

Pulse rate

Unchanged	15 patients
Fall	4
Rise	1
Total	20

Total dosage range of methohexital: 50 to 600 mg.
Anesthesia time: 3 to 120 minutes
Ambulation time: 10 to 300 minutes

TABLE III. BLOOD PRESSURE RECORDS OF TEN PATIENTS, PREOPERATIVELY, FOLLOWING EACH INJECTION OF METHOHEXITAL, AND POSTOPERATIVELY

PATIENT NO.	PREOPERATIVE	FIRST INJECTION	SECOND INJECTION	THIRD INJECTION	FOURTH INJECTION	FIFTH INJECTION	SIXTH INJECTION	POSTOPERATIVE
1	120/80	120/70	120/70	120/70	120/70	130/80	130/80	140/80
2	120/60	110/60	110/80	110/80				140/80
3	120/80	140/80	135/80	130/80	130/80	130/80		120/90
4	150/90	130/90						135/90
5	130/80	140/70	140/70	140/70				130/75
6	115/75	140/100	140/80					120/80
7	120/80	110/80						115/80
8	120/80	130/80						120/80
9	110/70	110/70						110/70
10	140/80	130/80	135/80					130/80

The above study reveals a rise and fall of systolic and diastolic pressures during the course of methohexital anesthesia. The reasons for these changes are not clear and require further study.

Systolic: Fall to 20 points, rise to 25 points.
Diastolic: Fall to 10 points, rise to 25 points.

7. There is less rise and fall in blood pressure following injections, and the return to the preoperative blood pressure level occurs sooner.

8. The wheel chair is seldom used. Most patients are walked to the recovery room and some recover so rapidly that they are discharged directly from the operating room.

9. Patients resume their duties at home or work much sooner.

10. Nausea and vomiting have ceased to be a problem since hypoxia is assiduously avoided, and the incidence of blood swallowing is reduced to a minimum since the patients awaken so quickly.

11. There have been no obstreperous teen-agers during the recovery period.

The disadvantages of using methohexital are as follows:

1. Less postoperative euphoria.
2. Hiccups, jactitations, and increased salivation.
3. Larger dosage is required in the longer procedures.

CONCLUSIONS

A new ultrashort-acting intravenous barbiturate anesthetic for the ambulant dental patient is described. The more important characteristic of this drug is its rapid recovery time. Of the intravenous anesthetic agents now in use, methohexital sodium is completely deactivated in the shortest time, and this single factor gives advantages not offered by the other barbiturates.

Methohexital sodium makes possible one of the safest techniques of general anesthesia developed to date for the ambulant dental patient.

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MEASUREMENT OF GONADAL DOSE IN CHILDREN DURING INTRAORAL RADIOGRAPHY

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INTRODUCTION

THIS investigation provided data for the evaluation of gonadal dose in male children incident to routine clinical intraoral radiography at 90 KVP and 15 Ma. with total filtration of 2.0 mm. aluminum equivalent.

It is anticipated that the accumulated data, coupled with the development of special research techniques, will provide a basis for further studies of the distribution of integrated body doses to children during intraoral radiography.

METHOD OF PROCEDURE

Eighty boys, ranging in age from 6 to 16 years, were used as subjects in the investigation. The following data were recorded for each patient: age, weight, distance from occlusal plane to gonads, and number of individual exposures.

Gonadal dose measurements were made during routine intraoral radiography at 90 KVP and 15 Ma. with an average individual exposure of $\frac{1}{15}$ second per projection. The x-ray machine was collimated to provide a beam 2.75 inches in diameter at the cone tip with an 8 inch target-skin distance. A total filtration equivalent to 2.0 mm. of aluminum was used. The measurement of the gonadal exposure was recorded on Kodak Personal Monitoring Film, Type 1, placed in a specially designed holder located on the dental chair, external to the clothing and just below the area of the scrotum.

In order to determine the amount of exposure that each gonadal-survey film received, it was necessary to prepare a set of standard-density films for

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TABLE I. SUMMARY OF DATA COLLECTED PER SUBJECT

PATIENT	WEIGHT (POUNDS)	HEIGHT (INCHES)	WEIGHT / HEIGHT	NO. FILMS	GONEDAL DOSE (MR)	MILLIROENTGENS PER FILM
1	59	16	3.7	12	0.8	0.066
2	49	19	2.6	14	1.7	0.121
3	53	14	3.8	12	2.6	0.216
4	46	17	2.7	12	1.9	0.158
5	49	16	3.1	12	1.1	0.092
6	56	17	3.3	12	1.0	0.084
7	52	19	2.7	14	1.1	0.079
8	36	16	2.2	12	3.0	0.250
9	54	17	3.2	12	1.7	0.142
10	54	18	3.0	12	2.3	0.192
11	62	17	3.7	12	1.7	0.142
12	55	19	2.9	14	2.1	0.150
13	77	18	4.3	16	3.2	0.200
14	77	15	5.1	16	3.0	0.187
15	65	18	3.6	14	1.7	0.121
16	93	18	5.2	16	0.7	0.044
17	72	19	3.8	18	3.6	0.200
18	62	17	3.6	12	1.0	0.084
19	71	18	3.9	14	2.3	0.164
20	82	17	4.8	14	3.8	0.271
21	57	17	3.4	14	1.0	0.071
22	60	18	3.3	14	1.8	0.129
23	76	18	4.2	18	1.4	0.078
24	85	20	4.2	14	0.8	0.057
25	93	22	4.2	16	1.1	0.069
26	85	19	4.5	18	1.9	0.105
27	71	21	3.4	16	1.7	0.106
28	80	22	3.6	14	1.9	0.136
29	97	22	4.4	16	1.9	0.129
30	78	18	4.3	14	2.7	0.193
31	70	20	3.5	18	3.1	0.172
32	95	19	5.0	14	0.8	0.057
33	123	18	6.8	16	0.9	0.056
34	64	17	3.8	16	1.9	0.119
35	78	20	3.9	14	1.4	0.100
36	143	21	6.8	20	0.8	0.040
37	100	20	5.0	20	0.9	0.045
38	82	21	3.9	18	0.8	0.064
39	76	19	4.0	18	1.0	0.055
40	68	18	3.8	13	0.8	0.062
41	75	21	3.6	18	5.0	0.278
42	76	20	3.8	18	1.0	0.055
43	82	19	4.3	14	0.9	0.064
44	94	21	4.5	12	1.7	0.142
45	95	22	4.3	18	2.3	0.128
46	85	19	4.5	12	0.7	0.058
47	103	22	4.7	18	0.8	0.044
48	107	20	5.4	14	0.8	0.057
49	119	22	5.4	18	1.4	0.078
50	96	17	5.6	16	1.4	0.087
51	149	25	6.0	18	0.8	0.044
52	105	21	5.0	14	0.8	0.057
53	84	19	4.4	20	1.4	0.070
54	80	20	4.0	18	1.4	0.078
55	95	21	4.5	18	1.0	0.055

(Continued on opposite page.)

TABLE I—CONT'D

PATIENT	WEIGHT (POUNDS)	HEIGHT (INCHES)	WEIGHT / HEIGHT	NO. FILMS	GONADAL DOSE (MR)	MILLIROENTGENS PER FILM
56	68	19	3.6	18	2.3	0.128
57	115	25	4.6	20	4.3	0.216
58	95	20	4.8	14	0.8	0.057
59	126	24	5.3	18	1.0	0.055
60	105	22	4.8	20	1.4	0.070
61	72	22	3.3	14	1.7	0.121
62	116	23	5.0	20	1.4	0.070
63	110	17	6.5	18	0.8	0.044
64	120	20	6.0	14	0.8	0.057
65	95	20	4.8	18	1.4	0.078
66	81	23	3.5	16	2.9	0.182
67	106	19	5.6	18	1.4	0.078
68	93	18	5.2	18	0.9	0.050
69	88	23	3.8	16	1.0	0.062
70	142	30	4.7	18	0.8	0.044
71	108	22	4.9	18	1.7	0.095
72	132	23	5.7	14	1.7	0.121
73	185	23	8.0	20	0.9	0.045
74	103	23	4.5	16	0.9	0.056
75	115	24	4.8	18	1.4	0.078
76	96	23	4.2	18	1.9	0.106
77	132	25	5.3	20	0.7	0.035
78	154	24	6.4	18	0.8	0.044
79	114	25	4.6	20	2.0	0.100
80	129	27	4.8	20	1.4	0.070

comparison purposes. The procedure was as follows: The Victoreen Condenser r-Meter with the 0.025 r chamber and Kodak Personal Monitoring Film, Type 1, were used to make a series of varying exposures. Since the radiation measured, as scattered from a phantom, was of a low-energy secondary type, two dosimeter films were used for each exposure. One film was placed on the side of the chamber nearest the radiation source. A second film was placed on the opposite side of the chamber. A series of six exposures, encompassing twelve films, was made. The twelve films were processed simultaneously with the gonadal-survey films. The densities of these twelve films were determined with the Macbeth densitometer, Model 12A. A standard density for each exposure was established by averaging the densities of each pair of films, and a standard curve (dose versus density) was prepared.

FINDINGS

Table I summarizes the data collected for each subject. Total dose to the gonads per patient ranged from 0.7 mr to 5.0 mr, with an average gonadal dose of 1.6 mr. The number of intraoral films exposed per patient varied from twelve to twenty, with an average of sixteen intraoral films exposed. There was no apparent relationship between the patient's age and the dose to the gonads. No correlative relationship was seen between occlusal plane–gonad distance and gonadal dose or between weight and gonadal dose (Tables II and III). The gonadal dose per exposure was found to decrease as the weight : height ratio increased (Table IV).

TABLE II. RELATIONSHIP OF OCCLUSAL PLANE TO GONAD DISTANCE AND RADIATION DOSE TO THE GONADS

OCCLUSAL PLANE TO GONAD DISTANCE (INCHES)	AVERAGE MILLIROENTGENS PER EXPOSURE
16	0.136
17	0.120
18	0.117
19	0.097
20	0.076
21	0.113
22	0.097
23	0.091
24	0.059
25	0.099

TABLE III. RELATIONSHIP OF PATIENT'S WEIGHT AND RADIATION DOSE TO THE GONADS

WEIGHT (POUNDS)	AVERAGE MILLIROENTGENS PER EXPOSURE
40- 49	0.124
50- 59	0.123
60- 69	0.113
70- 79	0.147
80- 89	0.102
90- 99	0.082
100-109	0.061
110 and over	0.073

TABLE IV. RELATIONSHIP OF WEIGHT:HEIGHT RATIO AND RADIATION DOSE TO THE GONADS

WEIGHT:HEIGHT RATIO	AVERAGE MILLIROENTGENS PER EXPOSURE
Up to 3.0	0.158
3.1-4.0	0.121
4.1-5.0	0.096
5.1-6.0	0.074
6.1 and above	0.046

DISCUSSION

The inverse relationship between gonadal dose and weight:height ratio indicates that the linear concept of occlusal plane–gonad distance is not the only criterion for gonadal-dose evaluation.

The need for additional integrated body-dose studies (thyroid, eye, hands, central nervous system, etc.) incident to intraoral radiography at various levels of energy and filtration is emphasized in the preliminary analysis of data in the current ten-state survey of radiation hygiene in dental offices.[1]

Inasmuch as these data indicate that wide ranges of x-ray dose levels are employed by practicing dentists, the present gonadal-dose study, conducted under relatively ideal conditions, will be expanded to encompass an investigation of integrated body-dose studies in children at these respective dose levels. For this study, a suitable phantom will be used in lieu of human patients.

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USE OF DENTAL X-RAYS IN ROENTGENOGRAPHY OF THE PALATOPHARYNGEAL MECHANISM

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INCREASING attention is being paid to the difficult situations that dentists encounter when treating patients with multiple problems. In the case of the cleft palate patient, there has evolved the practice of a team approach wherein specialists in the fields of orthodontics, prosthodontics, pedodontics, plastic surgery, speech pathology, otorhinolaryngology, and others pool their knowledge for the benefit of the patient. In treating patients with multiple problems, it is important that members of the health services assist each other whenever possible. This may be the case in the x-ray examination of the palatopharyngeal mechanism.

Lateral-skull roentgenograms were used in the observation of velopharyngeal relationships as early as 1925[1] Anterior laminagraphy has also been used for similar purposes.[2] Observations have been made regarding the effect of various structures (for example, the arch of the atlas or the adenoids), upon the nasopharyngeal space. Cineroentgenographic techniques, with or without simultaneous sound tape recordings, are vastly superior to roentgenograms in the observation of the velopharyngeal mechanism. However, the availability of these techniques is limited. The type of information gained by using x-radiation is useful to various persons interested in this particular area, and it is certainly of interest to the speech therapist in cases in which there is excessive nasality in speech. McKenzie[3] reports that measurements of velopharyngeal relationships obtained from lateral roentgenograms are statistically significant. This indicates that lateral roentgenography of the palatopharyngeal area can be useful in the evaluation of velopharyngeal closure. Speech therapists are now working in some public schools, and many are working away from large cities in areas where medical x-ray machines and other diagnostic tools are not readily available. It is possible that the dental x-ray machine, which can be found in all modern dental offices, may be of assistance to such persons and thus increase in its usefulness as an adjunct to the health services of the community.

TECHNIQUE

The technique used in making the roentgenograms presented in this article involves a 90 KVP dental machine (HVL of 2.2 mm. aluminum at 65 KVP)

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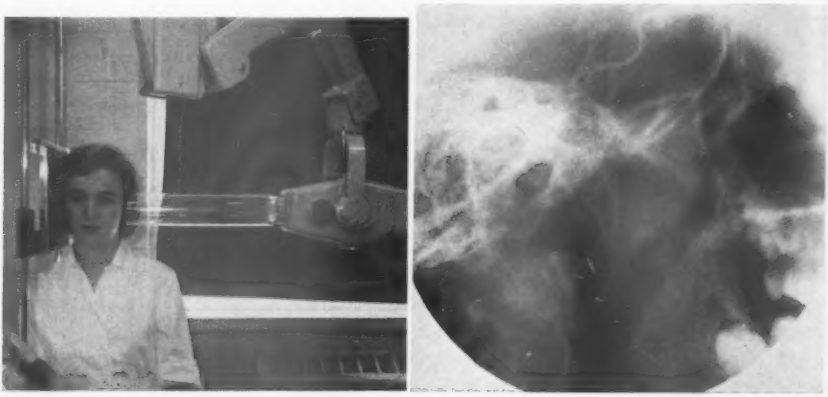
with a cone 16 inches long and an impulse or electronic timer. The film used was of the light-sensitive type* in a par-speed cassette. The exposure factors used were very similar to those utilized in making a periapical roentgenogram of the upper molar area with the fastest dental film. Specifically, these factors were (1) 90 KVP, (2) 15 Ma. (3) a total filtration of 2.5 mm. of aluminum (equivalent), (4) a target-skin distance of 16 inches, (5) a beam of radiation, at the skin of the patient, 2.75 inches in diameter, and (6) an exposure time of 0.2 second. The patient's head was positioned so that the sagittal plane was planoparallel to the film, and the central ray was directed toward the soft palate perpendicular to the sagittal plane in both the horizontal and the vertical angles. Exposures were made while the patient was at rest or during the prolonged phonation of the "S" sound.



A. *B.*

Fig. 1.—*A*, Photograph showing relationship of patient, film, and tube. *B*, Typical roentgenogram obtained when patient is at rest.

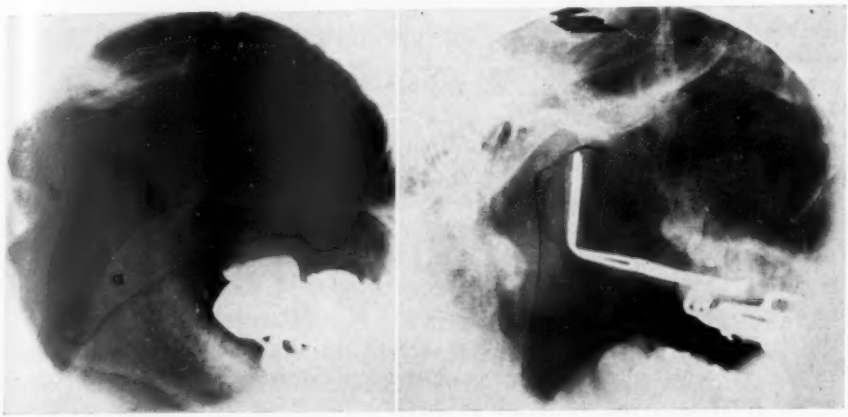
Fig. 1, *A* shows the patient, film, and tube relationships. Fig. 1, *B* shows a typical roentgenogram taken with the patient at rest. Figs. 2 and 3 show roentgenograms made with x-ray equipment commonly found in many modern dental offices. Tracings have been done on parts of these roentgenograms to point out the various structures more clearly to the uninitiated reader. Roentgenopaque material applied to the palate and pharynx before exposure would aid visualization of these structures in the roentgenogram. This procedure is unnecessary, however, as the roentgenographic contrast of these structures is great enough to make them easily identifiable.

DISCUSSION

The possibility of using the dental x-ray machine for the observation of the palate and adjacent pharynx while the patient makes a prolonged sound became a reality with the development of the newer x-ray machines. These

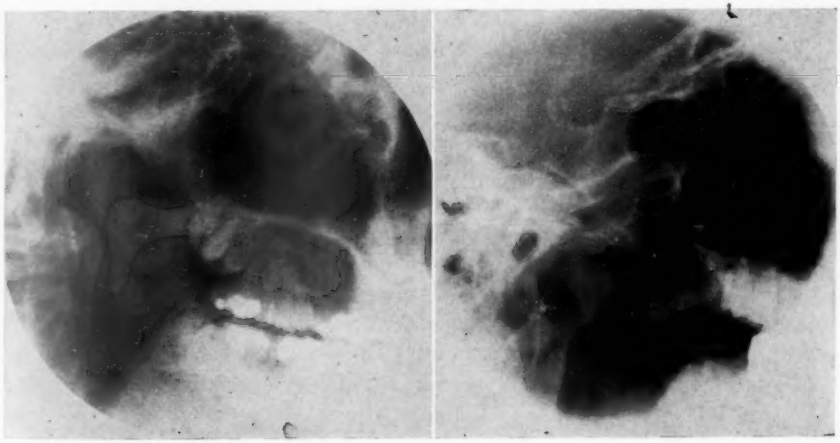
*Kodak Blue Brand film.

machines, which have timing mechanisms accurate to one-thirtieth of a second, are able to make the necessary short time of exposure. These machines are also able to give high peak kilovoltages that not only improve the soft tissue contrast but also deliver more energy to the film per unit of time, thus requiring



A. *B.*

Fig. 2.—*A*, Roentgenogram of patient in rest position. Tracing is done to facilitate identification of (a) the soft palate and (b) the arch of the atlas and "Passavant's ridge." *B*, Roentgenogram of a patient wearing a meatal type of obturator.



A. *B.*

Fig. 3.—*A*, Roentgenogram of a normal patient during prolonged phonation of the "S" sound. *B*, Roentgenogram of a patient with a repaired cleft palate during prolonged phonation of the "S" sound. The mass of the pharyngeal tonsils (adenoids) is indicated by the arrow.

less exposure time. Many machines can now be operated at 15 Ma., thus further reducing the exposure time. The use of the highest kilovoltage (90 KVP) and milliamperage (15 Ma.) enables the roentgenologist to increase the tube-patient distance (up to 16 inches) and still keep the exposure time within

workable limits (less than one-fifth of one second). The maximum tube-patient distance is desirable, since greater distance increases the image sharpness of the structures being examined and also reduces the patient's dose of radiation to some extent. The radiation dose to the patient is very low when these roentgenograms are made, and it has been shown that the exposure factors needed are similar to those used in making a single intraoral roentgenogram with the fastest dental films.

The positioning of the patient is of some importance. While a cephalostat would be of assistance in this respect, it is not of very great importance since both of the structures under examination are situated in the sagittal plane and the operator can, with reasonable care, easily achieve the correct position of the patient's head. Of more importance are the instructions given to the patient for making the prolonged "S" sound. The operator should have the patient practice this sound a few times before the roentgenographic exposure is made. This permits the operator to judge when to make the exposure, since he should hear the patient making this sound before and after the x-ray exposure.

It is not the purpose of this article to evaluate velopharyngeal relationships. The material is presented only to demonstrate the ability of the modern dental x-ray machine to make this type of roentgenographic examination and to acquaint the dentist with the simplicity of the technique involved.

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DEVELOPMENT OF A PROFILE-INTENSIFYING SHIELD FOR CEPHALOMETRIC ROENTGENOGRAPHY

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INTRODUCTION

Analysis of the soft-tissue profile is arousing increasing interest among orthodontists, who for thirty years have been concerned almost exclusively with the study of the bony profile in cephalometric films. The assumption that soft tissue was simply a reflection of the underlying hard-tissue framework[1] has been seriously questioned by recent investigations. Subtelny[2] stressed the need for soft-tissue analysis in addition to hard-tissue study after finding wide differences in soft-tissue thickness in various areas of the profile. The finding of differential rates of growth characteristic of various profile soft-tissue areas intensified his interest in the relationship between tissue and skeletal profile.

THE PROBLEM

One very mundane factor which has tended to perpetuate the long years of apathy toward the soft-tissue profile is the fact that in a large percentage of lateral cephalometric films taken for clinical study it has been almost impossible to see the soft tissue. It has been stated that with exacting control of exposure and development factors in the roentgenographic technique both hard and soft tissues can be adequately shown,[3] and this is undoubtedly true.

Yet, most cephalometric roentgenograms are not taken by experts in roentgenography; they are taken by personnel trained to a greater or lesser degree by orthodontists. As a result, exposure and development factors are not always ideal and may not even be adequate to produce a readable film.

Those who have traced any number of headfilms have also discovered that they can see both soft and hard tissues on a film in which the density and contrast are far from ideal if they view the film in absolute darkness and allow light to pass through the film only in the area to be examined. Viewing under optimal conditions may not always be practical, however, when the films are to be studied in the dental office or at study club meetings. Even viewing

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films under the best of conditions imposes problems, for the eyes tire very quickly when forced to concentrate on only one source of light.

The problem which confronts us is one of trying to record on one film two tissues of widely varying density. The gradations in density from the cranial base area to delicate bony structures, such as the nasal bones and anterior nasal spine, and the soft-tissue profile are very wide indeed. An exposure which will show any one of these areas in its fullest detail will be inadequate for the other tissues. The best that we can achieve with a standard technique is an exposure which is a compromise—a film with an over-all gray color which will be passable for all tissues. It is apparent that one must tread a very fine line to do this; in every headfilm collection there may be found films which are wholly unreadable in either the soft-tissue or the hard-tissue areas. It is not at all unusual to be unable to see soft-tissue detail in films taken in university and research cephalometric laboratories.

SOME POSSIBLE SOLUTIONS

A method described by Downs[4] for showing good detail involves the use of an additional strip of film in the cassette placed under the intensifying screen on the side toward the patient. A double-film technique was previously used by Simpson[5] in 1928 and by Thompson[6] in 1932.

The strip is 2½ inches wide and receives less radiation exposure by virtue of being in contact with only one screen. Development of the strip is similar to that of the over-all film, and the detail thus recorded is incorporated into the tracing of the full headfilm. Placing the strip in the cassette involves handling and bending the intensifying screen, however, and developing and handling of the strip during study as well as the storing of it, require unusual care. In addition, recording of anterior detail out of context may lead to confusion in interpretation.

Korkhaus[7] favors Hofrath's suggestion that the area of the film which records the soft-tissue detail be reduced chemically to lighten the image and thus bring out this detail in context with the skull. Another technique which has been used extensively involves application of a roentgenopaque paste directly to the profile of the patient. Advocates of this latter technique include Carrea[8] and Schwarz.[9] Both of these methods involve an extra technical procedure which most would prefer to avoid if possible.

SHIELDING TECHNIQUES

The method most frequently used today is based on a filter effect to reduce the amount of radiation received by the area of the soft-tissue profile. This method alone can result in some degree of reduction in radiation to the patient. More significant is the possibility of recording all the tissues of the head and face with clarity and detail on a single film without any cumbersome additional technical procedures.

The degree of roentgenopacity of the shield may vary widely according to its design and placement, which may be anywhere between the patient and the focal spot of the x-ray tube. A graduated lead screen fixed permanently quite close to the focal spot is used at the University of Indiana, and this generalized shielding apparently gives adequate soft- and hard-tissue visualization.[10] The shielding is generalized rather than specific for individual profile contours.

An adjustable shield attached to the x-ray tube stand is one method currently in use. Compensation for variation in size is accomplished by moving the shield or interchanging shields of various sizes. This minute adjustment can be made with the aid of a point source of light directed by a mirror along the pathway of the x-ray beams. The shield is moved into the light beam until it shades the profile of the subject to the desired amount, allowing selective filtration of the x-ray beam when the exposure is made. While this method can produce uniform and excellent results, it does involve an extra and time-consuming technical procedure and the equipment is rather expensive.

DEVELOPMENT OF A NEW SHIELD

When the shield is attached directly to some part of the head holder, the problem of adjustment becomes much less critical because of the lessening enlargement factor as the patient is approached. The problem of adjustment can be eliminated altogether if the shield can be attached to a part of the apparatus which is maintained in a constant relationship to the profile. In the Broadbent-Bolton cephalometer this part is the vertical anterior plastic plate which carries the nasion rest. This plastic plate is sufficiently stable to support some additional weight without any shift in position.

As an initial procedure, a temporary shield was built up of a barium sulfate powder dispersed in wax on a sheet of masonite hardboard. This was attached to a support which would slide down onto the anterior plastic plate of the headholder and hold the shield parallel to the midsagittal plane of the head and 12 cm. from this plane toward the x-ray source. Numerous trial films were then exposed to determine the correct relationship of the shield to nasion rest. After a study of the profile position on a random selection of headfilms from the University of California cephalometric library, a contour was derived which, when held in constant relation to the nasion rest, might be expected to be satisfactory for nearly all patients.

Headfilms of patients were then exposed with the barium-in-wax shield in place, and further modification of contour and thickness was carried out as study of the films dictated. The shield proved to have a mottled texture, as typified by the film shown in Fig. 1. Soft-tissue detail is adequate, but it was impossible to eliminate the uneven appearance with this material.

The shield was then reproduced in pure aluminum machined to cast an x-ray shadow similar to the preliminary model. The weight of the entire shield and support was only 10 ounces, which was not enough to disturb the alignment of any part of the head holder. The design and contour of the

Fig. 1.

Fig. 2.

Fig. 1.—Headfilm taken with temporary barium shield.
Fig. 2.—The aluminum shield.

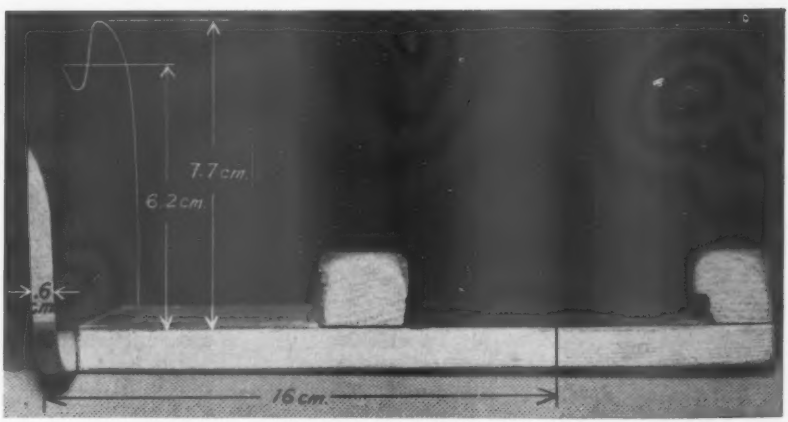

Fig. 3.—The aluminum shield.

shield are shown in Figs. 2 and 3. The shield is 6 mm. thick and must taper evenly to a knife edge toward the patient, so that it will be unobtrusive in the resultant lateral headfilm.

Fig. 4.

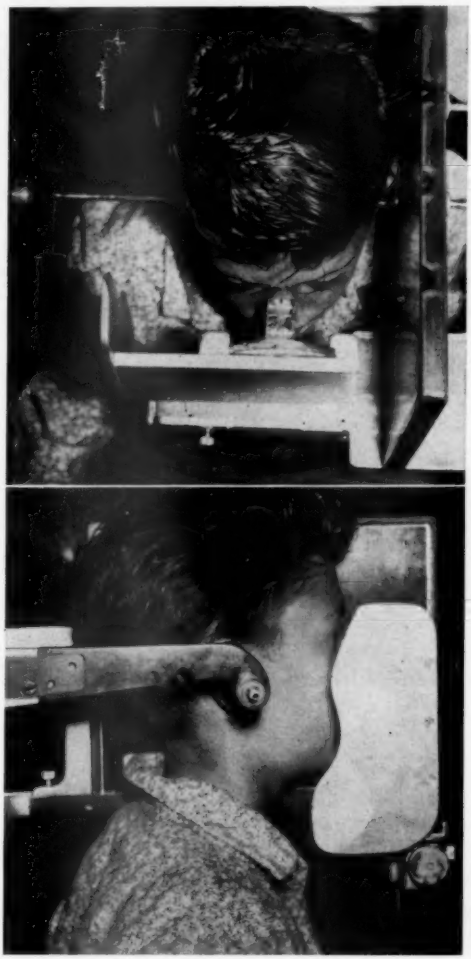

Fig. 5.

Figs. 4 and 5.—The shield in use.

The position of the shield in use is shown in Figs. 4 and 5. The entire procedure of positioning the patient is carried out as usual, and the shield is slipped into place just before the film is exposed. Headfilms taken before and after introduction of the shield into the cephalometric procedure are shown

in Figs. 6 and 7. The advantages of using this shield in our cephalometric procedure might be enumerated as follows:

1. Lateral cephalometric films are exposed ideally for hard-tissue detail while still recording soft-tissue detail in context, which can be studied under ordinary room-light conditions.

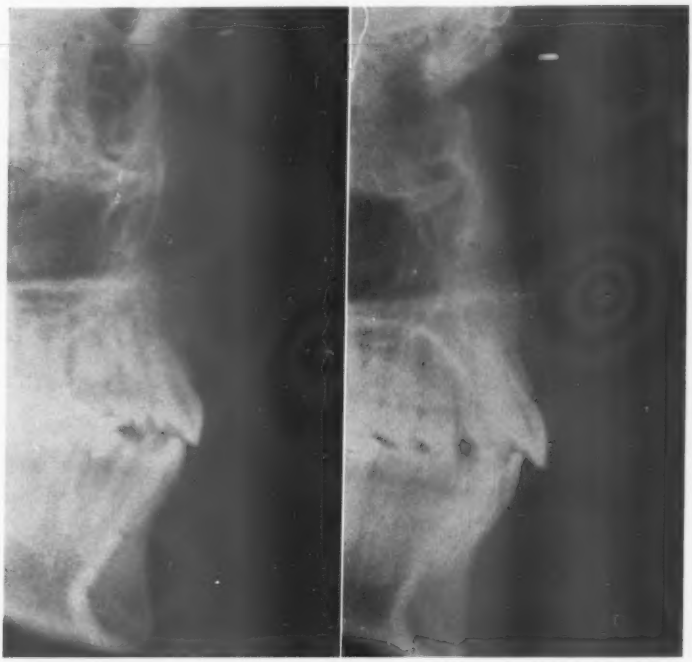

Fig. 6. Fig. 7.

Fig. 6.—Headfilm taken without shield.
Fig. 7.—Headfilm taken with aluminum shield.

2. By virtue of its attachment to nasion rest, a single shield is self-adjusting to wide variations in patient size.

3. Positioning the shield takes no more than ten seconds of the technician's time per patient.

4. The shadow of the edge of the shield is unobtrusive, and the design is such that anterior hard-tissue detail will not be lost.

5. Construction of the shield is inexpensive and not complicated.

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ROENTGENO-QUESTIONS

Why do some cavities appear to involve the pulp when, after the decayed dentine is carefully removed, the pulp is not exposed?

When shadows of teeth are cast onto a film, three-dimensional tissues are projected onto a two-dimensional film. The dimension of depth is not retained. All structures in the line of the x-rays are projected onto the same area of the film. If the cavity should extend between the two horns of the pulp, or between the pulp and the buccal or lingual surfaces of the tooth, or if the angle of x-ray projection through the tooth were such that the carious lesion was cast onto the pulp, then a cavity might appear to invade the pulp. It is possible to make a cavity appear to approximate or actually involve the pulp through mechanical means. It is not possible, by ordinary techniques, to make the cavity appear farther away from the pulp than it actually is. An exception to this statement may exist in the case of anterior bitewing films.

Why is it that cavities located on the labial, buccal, and lingual surfaces are almost impossible to see in dental films unless they are very large?

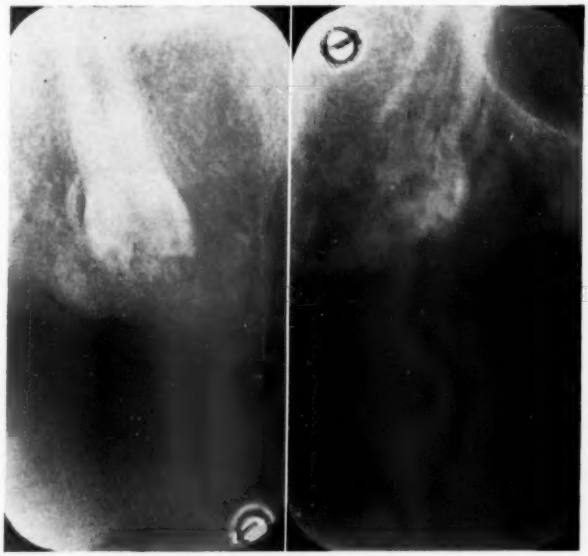
Shadows are created on dental films by the variation in absorption of the radiation as it passes through the dental structures. Absorption is influenced by the density and thickness of the structures. For 70 KVP units or lower, tissue density appears most critical; for 80 KVP units or higher, it is the volume of the object that is the determining factor. When x-rays pass through the more dense or thicker structures (for example, the posterior teeth), the area of destruction (for example, a carious lesion) is superimposed upon considerable bulk. A shallow but broad cavity will not have as much roentgen-ray absorption differential as a deep cavity. Careful clinical examination must supplement roentgenographic studies to ensure a valid diagnosis.

The American Academy of Oral Roentgenology solicits from the readers of ORAL SURGERY, ORAL MEDICINE AND ORAL PATHOLOGY any questions which deal with technical or interpretive aspects of oral roentgenology. These questions should be sent directly to the editor of this section, Dr. Arthur H. Wuehrmann, School of Dentistry, University of Alabama Medical Center, Birmingham, Alabama; the editor will distribute them for reply to a suitable group within the Academy. Questions, with the answers, will be published at as early a date as possible in "Roentgeno-Questions." Questions, especially those of an interpretive nature, should ordinarily be accompanied by good-quality roentgenograms and a pertinent history. The names of the questioner and the respondent will not be published.

ROENTGENO-ODDITIES

Resorption of Retained Teeth

The case presented here shows bilateral retention of the permanent upper cuspids. These teeth were discovered upon routine roentgenographic examination of an elderly woman. Both of these teeth show extensive resorption of all the calcified structures. Resorption of the roots of teeth is not an uncommon phenomenon and can be caused by various factors, such as pressure, abscesses, etc. Resorption of the enamel, however, is relatively rare, and the



Each month this section will bring to the readers of ORAL SURGERY, ORAL MEDICINE AND ORAL PATHOLOGY one or more roentgenograms which demonstrate unusual, unexpected, rare, or bizarre roentgenographic changes. These roentgenograms will be accompanied by an explanation or by words of inquiry regarding the particular change. All films used in this section will be accepted with the understanding that 2 by 2 or 3¼ by 4 inch slides or glossy photographs of the films will be made available to interested readers through the editor of the American Academy of Oral Roentgenology at the individual's expense. The cost will involve only the photographer's charges. Each slide or print will give credit to the donor. Interesting roentgenograms are solicited from all sources. Please be certain to identify your films properly so that they can be returned. All material for publication should be submitted to Dr. Arthur H. Wuehrmann, University of Alabama School of Dentistry, Medical Center, Birmingham, Alabama.

case shown here can be classified only as an idiopathic form of tooth resorption, as no causative factor can be identified.

The cause of tooth retention is not clearly understood, but the clinical implications are evident; this condition certainly creates problems for the dentist. Some of these problems are related to shifting teeth, replacing the deciduous precursor when it is lost, and psychic trauma to the patient. The treatment of retained teeth varies with the individual. Some dentists recommend the removal of all retained teeth because they fear the possibility of a cyst and/or ameloblastoma occurring at a later date; some ignore them; others assume a wait-and-watch attitude. The case presented here shows the possibility of retained teeth remaining asymptomatic for a very long period of time and even undergoing considerable resorption.

Lincoln R. Manson-Hing
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ORAL PATHOLOGY

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BREAST CARCINOMA METASTATIC TO MAXILLA

Report of a Case

Harris Blake, D.D.S., and Fred S. Blake, D.D.S.,** Paterson, N. J.*

IN 1956 Aisenberg and Inman pointed out that malignant tumors often metastasize to bone—more frequently to flat bones than to long bones. They said that this is thought to be due to the higher degree of vascularity of red marrow over yellow marrow.

The dentist often has the problem of identifying pathologic lesions of bone. In studying roentgenograms of his patients, he observes what is literally a "hole in the bone." The ultimate question is: "What is the hole filled with, and what caused this lesion?" It is here that close cooperation between the dentist and the oral pathologist will quickly crystallize the issue.

There is no single clinical method for the differential diagnosis of oral lesions; it is important that all diagnostic facilities be used, but in the final analysis biopsy is the best aid at our command.

CASE REPORT

A 59-year-old white married woman was referred on Oct. 18, 1957, with a complaint of intraoral swelling and pain in the right maxilla. Her attention was drawn to this area several days prior to examination, when she first noticed that her upper denture, which she had worn for five years, caused pain on insertion. She also experienced tenderness during mastication. She reported to her dentist, requesting that her upper denture be adjusted to give her relief in the area. X-ray films were taken and the patient was referred to this office for further evaluation and treatment.

Past History—In March, 1954, a radical mastectomy of the left breast was performed. There were palpable nodes in the left axilla. In September, 1954, the patient was treated for a fracture of the left humerus. In January, 1955, a hernioplasty was performed for repair of a left strangulated inguinal hernia. In June, 1955, an open reduction was done on the left humerus for reduction of a nonunited fracture.

Examination.—The patient was a well-developed middle-aged woman in no distress except for the tender area in the right maxillary region. There were no swellings extra-

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orally, but there were palpable lymph nodes in the neck. Intraoral examination showed the patient to be edentulous in both the upper and lower jaws and wearing full upper and lower dentures. There was a slight bulging in the right upper molar area, making it difficult to seat the upper denture. The swelling was tender to touch. The mucous membrane overlying the swelling was slightly inflamed due to the irritation caused by the denture.

Roentgenographic Examination.—Occlusal and intraoral roentgenograms showed an extensive osteolytic lesion involving the right maxilla (Fig. 1).

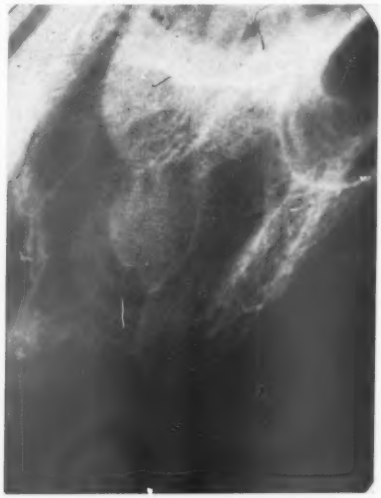

Fig. 1.—Intraoral roentgenogram showing an extensive osteolytic lesion involving the right maxilla.

A preoperative diagnosis of metastatic carcinoma or sarcoma was made.

Operation.—On Oct. 19, 1957, the patient was given premedication of 2¼ gr. Seconbarbital and anesthetized with 2 per cent Xylocaine and epinephrine 1:100,000. An incision was made on the alveolar ridge, a flap was retracted, and the shell-like bone was removed, exposing the mass. A section of the lesion was removed for pathologic study.

Pathologist's Report.—Dr. Jacob Churg of the Barnert Memorial Hospital reported that the microscopic examination showed masses of tumor tissue lying in dense connective stroma. The tumor cells were of the epithelial type and were arranged in smaller and larger nodules surrounded by a thin layer of stroma (Fig. 2). The individual cells were moderately large and had pink or slightly vacuolated, poorly defined cytoplasm and vesicular nuclei which varied in size and in staining reactions. A moderate number of mitoses were seen (Fig. 3). In places, deposits of brown iron pigment gave evidence of old hemorrhages, and there were also multinucleated giant cells of the foreign body or osteoclastic type.

When the oral tumor was compared with the original tumor of the breast, there was seen to be a marked similarity in appearance and arrangement of cells.

Diagnosis: "Metastatic solid carcinoma. Histology compatible with origin in the breast."

Postoperative Treatment and Course.—The patient was able to wear her upper denture more comfortably following excision of a portion of the lesion. She was referred to her physician for further x-ray studies of the skull and chest and for re-evaluation of the case. X-ray films taken of the facial and maxillary bones on Nov. 9, 1957, again showed the

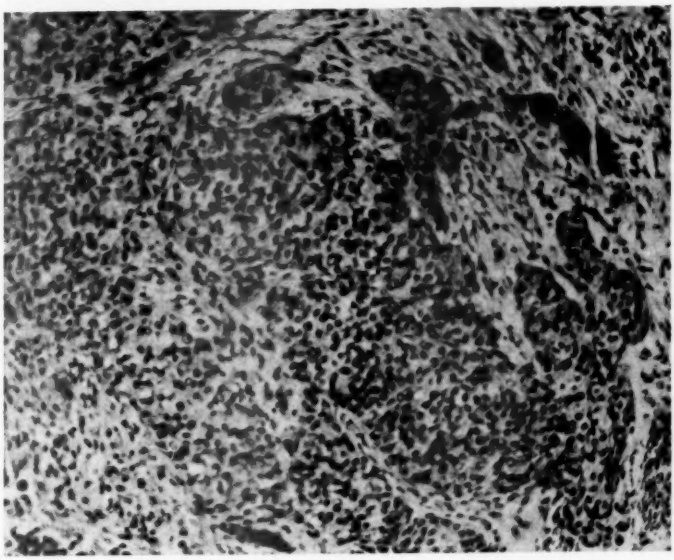

Fig. 2.

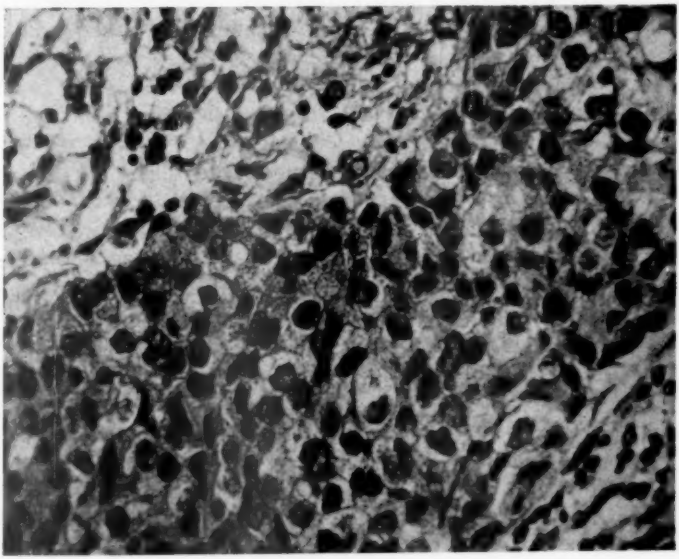

Fig. 3.

Figs. 2 and 3.—Photomicrographs of metastatic carcinoma from breast affecting the maxilla. (Magnifications: Fig. 2, ×200; reduced ⅓. Fig. 3, ×500; reduced ⅓.)

osteolytic lesion in the anterior portion of the right maxillary bone, just beneath the anterior nasal process, with moth-eaten irregular borders. The appearance was consistent with metastatic neoplasm.

The lateral view of the skull showed an inconclusive osteolytic lesion in the superior portion of the frontal bone which suggested the possibility of another metastatic focus.

Radiographic examination of the chest revealed a pleural effusion on the left side with the fluid level opposite the fourth rib anteriorly. A hazy, dense area was also noted in the region of the costophrenic sinus, where there also appeared to be a pleural effusion. These findings were probably the result of metastatic neoplasm.

The patient received 100 mg. of testosterone intramuscularly three times weekly in addition to 15 mg. of Meticorten daily. One month later she was referred for deep x-ray therapy to the right maxilla, and she was requested not to use the upper denture. Because of chest pain, additional chest roentgenograms were made on Dec. 10, 1957. These showed pleural effusion on the left side with the level opposite the third rib anteriorly. An irregular infiltration was also noted in the right lung field, presumably due to a metastatic neoplasm.

On Dec. 13, 1957, a left thoracentesis was performed, and approximately 900 c.c. of serosanguineous fluid was removed. The laboratory report stated that the pleural fluid showed many nests of carcinoma cells, the origin of which was compatible with the original breast lesion.

Following a course of deep radiation therapy to the maxilla, the tumor decreased in size, permitting the patient to wear the denture without pain or discomfort for a period of several months.

The patient's condition subsequently showed deterioration, and she died on June 16, 1958.

COMMENT

1. When patients appear for denture adjustments, further studies should be performed if there are any deviations from the usual denture irritations.

2. A general medical history is important, since it may direct one's attention to a clinical diagnosis.

3. Metastatic lesions to the maxilla from breast carcinoma are rare. The usual metastatic bony foci from breast carcinoma are found in the pelvis, the spine, the skull and occasionally the long bones.

4. The case reported here also confirms the important role that the dentist can play in the diagnosis of cancer in the oral regions. In many instances the dentist can detect the presence of cancer at a stage in which it can be cured.[2]

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646 BROADWAY.

RECURRENT ADENOID CYSTIC CARCINOMA OF THE SUBMAXILLARY GLAND

James F. Smith, B.S., D.D.S., Ph.D., Memphis, Tenn.*

ADENOID CYSTIC CARCINOMA, which is a type of adenocarcinoma, may have its origin in the parotid gland, the submaxillary gland, the accessory salivary glands, and such extraoral sites as the lacrimal glands and glands of the paranasal sinuses.

This tumor, which has been called cylindroma, basaloid mixed tumor, and adenocystic basal-cell carcinoma,[1] occurs in later life, usually after the age of 40. It may occur earlier, however, as in the case to be reported here.

Adenoid cystic carcinoma affects both sexes equally. If the parotid gland is the site of origin, there may be involvement of the seventh nerve with resultant facial paralysis. By its persistent growth, this tumor may involve the cranium when it has its origin in the accessory salivary glands of the palate. Sites involved by metastasis of this tumor may be regional lymph nodes, lungs, brain, and bones.[2]

The tumor usually has a slow, persistent growth pattern, and it recurs if inadequately treated. Because of its slow growth and peculiar patterns, this tumor may be mistaken for a benign lesion; when this happens, the prognosis is grave.

A capsule is usually present in adenoid cystic carcinoma, but it may fail in many cases to contain the tumor completely. Grossly, the tumor is very similar to mixed tumor of the salivary glands; here too, its benign appearance may be misleading.

On microscopic examination, the tumor is seen to be composed of small cells that resemble the basal cells of the epithelium. These cells, which have dark-staining nuclei and very little cytoplasm, are commonly arranged in cords or as islands or acini. The stroma, of which there is usually a moderate amount, may be arranged in cylinders (hence the name "cylindroma"). The tumor cells may grow along perineural lymphatics or sheaths (a rather common finding).

CASE REPORT

The patient, a 34-year-old white woman, had noticed a swelling in the floor of the mouth and had experienced some difficulty in swallowing as well as pain in the region. Three

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Fig. 1.—This illustration demonstrates an area in the patient's neck which is the recurrent adenoid cystic carcinoma that has extended posteriorly from its original site.

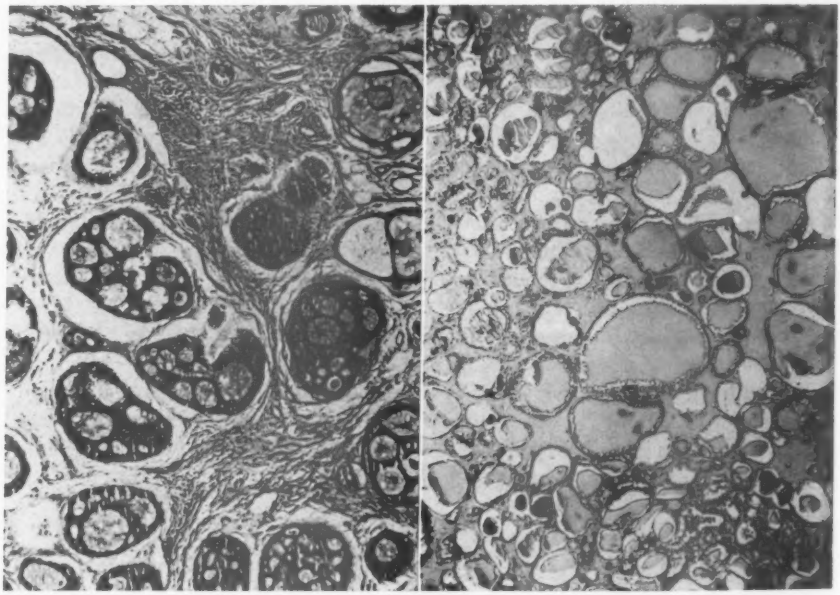

Fig. 2. Fig. 3.

Figs. 2 to 4.—Three different cellular arrangements seen in adenoid cystic carcinomas.

years earlier a tumor in this same area had been diagnosed as adenoid cystic carcinoma and removed surgically. At the time of the patient's first visit, when she was 31 years of age, there were no palpable nodes. Three years later, however, palpable nodes were found and neck dissection was advised. The tumor had been incompletely removed when the previous operation was performed. Now the treatment of choice was mandibular resection and neck dissection, with follow-up irradiation.

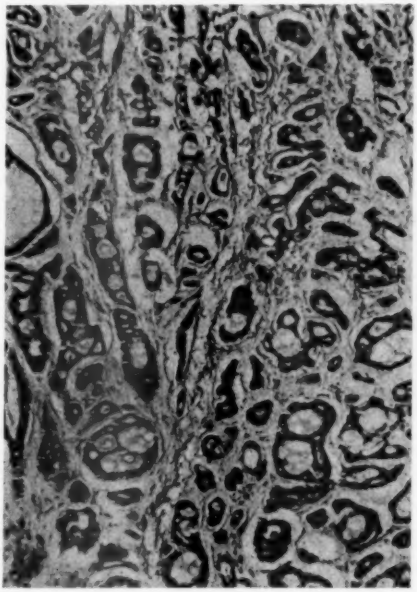

Fig. 4.—*(For legend, see opposite page.)*

CONCLUSION

Because of the invasive tendencies of adenoid cystic carcinoma, early diagnosis and prompt treatment are of utmost importance.

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DIAGNOSIS OF MANDIBULAR JOINT DYSFUNCTION

James Copland, M.Ch.D., L.D.S., Leeds, England

ANATOMIC ASPECTS

THE detailed anatomy of the temporomandibular articulation is described fully by Sicher,[20] Diamond,[8] and Shapiro.[19] The articulation can be described as a ginglymo-arthrodial joint (that is, a combination of hinge and free gliding movements).

The mandibular condyle articulates with the glenoid fossa of the temporal bone, the fossa continuing anteriorly on to the articular eminence or glenoid tubercle. The joint is surrounded by a fibrous capsule lined with synovial membrane and reinforced on its lateral aspect by the temporomandibular ligament. The joint cavity is divided into a larger upper and a smaller lower compartment by the articular disc or meniscus. That part of the capsule which lies above the disc hangs loosely, so that free gliding movements can take place in the upper compartment.

THE ARTICULAR DISC

The articular disc is a fibrous tissue structure which conforms closely to the shape of the articular surface of the condyle and is thinner in its central area than at the periphery. Blood vessels and nerves are found only in the peripheral regions, particularly in the posterior position which consists of loosely arranged vascular connective tissue and contains elastic fibers which may play a part in the return of the disc after forward excursions. The upper fibers of the lateral pterygoid muscle are inserted into the anterior aspect of the disc (Figs. 1 and 2).

Sicher[22] contends that the disc follows passively all sliding movements of the mandible and that mobility between condyle and disc is confined to a pure hinge movement, the attachment of the lateral pterygoid muscle being designed to maintain balance rather than to bring about forward movement of the disc.

Movements of the disc have been studied on anatomic specimens by Rees[15] and Landa.[12] In some of their material the discs were studied through windows opened in the floor of the middle cranial fossa, and both authors describe a flattening or stretching of the disc associated with forward movement of

From the University of Leeds.

the condyle, the actual bodily movement of the disc being very limited. Rees describes four distinct transverse zones or bands in the disc, each band assuming a different position relative to the condyle as the latter moves forward. Although dissections carried out on postmortem specimens cannot reproduce functional movements, such as the effect of the contracting lateral pterygoid

Fig. 1.

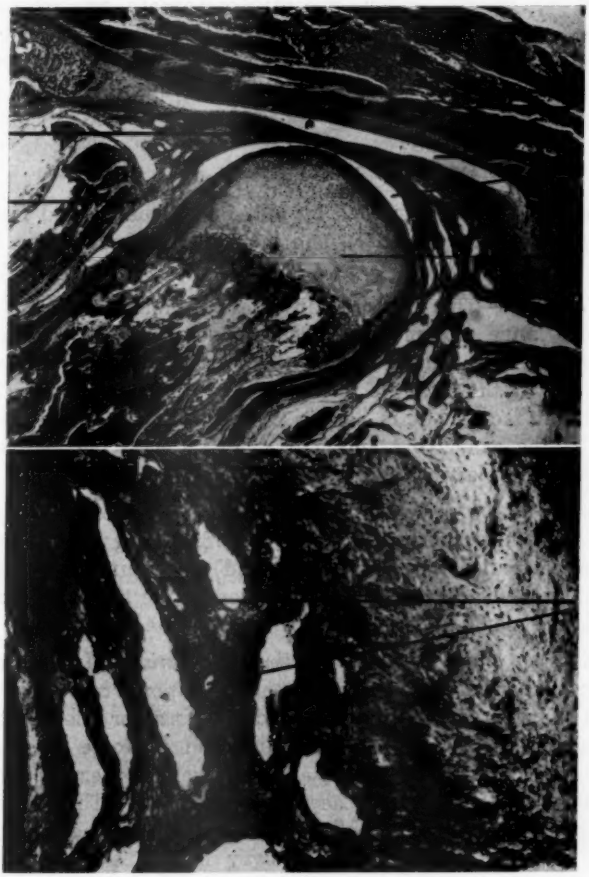


Fig. 2.

Fig. 1.—Sagittal section through left mandibular joint of fetus 280 mm. C. R. *T*, Temporal bone; *JC*, upper and lower joint cavities; *D*, disc; *C*, developing condyle; *M*, attachment of lateral pterygoid muscle to anterior margin of disc. *Note:* The glenoid tubercle has not yet developed at this stage. (Mallory stain. Magnification, ×18; reduced ⅙.)

Fig. 2.—Higher-power view of posterior part of the disc showing loosely arranged vascular connective tissue. *BV*, blood vessel. (Mallory stain. Magnification, ×78; reduced ⅙.)

muscle on the articular disc, these and other functional mandibular movements were induced artificially. The methodical care with which these authors carried out their investigations removes any doubt as to the value of their findings.

Sicher[21] points out that the avascular fibrous tissue of the central area of the disc is adapted to resist pressure and that islands of cartilage appearing in the fibrous tissue in later age periods can be regarded as a response to pressure and friction. Roydhouse[16] is also of the opinion that the mandibular joint is pressure bearing.

It seems pertinent to point out, however, that the presence of the important condylar growth center immediately beneath one of the articular surfaces is scarcely consistent with the view that the mandibular joint is a pressure-bearing structure. In fact, an analysis of the actions of the muscles attached to the mandible indicates that a mechanism exists to protect the joint from pressure.

THE ACTION OF THE MANDIBULAR MUSCULATURE

Last[13] assessed the role played by individual muscles and muscle groups in the movements of the mandible, and many of his findings are included in the analysis that follows.

Mouth-Opening.—This movement involves a combination of forward gliding movement and hinge movement of the condyle. The forward movement is brought about by the contraction of the lateral pterygoid muscle and the hinge movement by the action of both bellies of the digastric muscle. Gravity is not a relevant factor, but in certain cases depression of the mandible may be assisted by the geniohyoid and mylohyoid muscles, the depressors of the hyoid bone and the platysma.

Protrusive and Lateral Movements.—Symmetrical forward excursions are carried out by simultaneous contraction of both lateral pterygoids, while the elevators (in particular the medial pterygoid) maintain the relative position of the mandible to the maxilla. If contraction of the lateral pterygoid muscle is unilateral, the mandible will move to the opposite side.

Mouth-Closing and Pressure-Adjusting Mechanism.—In a study of mandibular joint function, Scott[18] found that the powerful group of muscles consisting of the masseter, medial pterygoid, and anterior fibers of the temporal muscle which close the mouth and would tend to force the condyle head against the roof of the glenoid fossa are prevented from doing so by the action of the posterior fibers of the temporal muscle. These posterior fibers are attached to the coronoid process and, acting across the root of the zygomatic arch, tend to draw the condyle away from this position of pressure. They are assisted in this function by the lateral pterygoid muscle, and protection is also afforded by the semirigid structure of the articular disc.

Masticatory Movements.—These movements are essentially combinations and variations of the simple mandibular movements. In most instances the force exerted by the elevators is considerable, and the stabilizing actions of the lateral pterygoid muscles and the other components of the pressure-adjusting mechanism are called into play to prevent pressure effects on the joint structures.

Rest Position.—The physiologic rest position of the mandible is dependent largely upon the equilibrium of the mandibular musculature and is subject to individual variations. When the mandible is at rest, the upper and lower teeth are not in occlusion but are separated by an interocclusal free-way space which has been found by Landa[12] to vary from 1 to 8 mm. in different individuals.

These observations emphasize the importance of maintaining a normal pattern of muscle behavior if the integrity of the joint structures is to be preserved. Harmonious and balanced muscle function is maintained by nerve reflexes, the components of which consist of, on the one hand, proprioceptive nerve endings in the periodontal membranes, muscles, articular capsule, and peripheral regions of the disc and, on the other, the motor nerves to the muscles.

MATERIAL USED

The material upon which this investigation is based consists of 186 cases which I have examined and treated at the University of Leeds Dental School and Hospital over a period of six years. The majority of these patients were referred by medical or dental practitioners, and they had either obvious symptoms of mandibular joint dysfunction or symptoms (mainly pain) of obscure origin. During this six-year period an additional fourteen patients were referred for treatment of mandibular joint dysfunction, but after investigation the symptoms of which they complained were attributed to other conditions. Some of the points relevant to the differential diagnosis of these cases will be discussed later.

Additional histologic information has been gained from the study of material obtained from two fetuses and from six cases on which condylectomy was performed by Professor T. Talmage Read. My observation of the structures of the mandibular joint in situ while I was assisting at the above operations has also been of considerable value.

INVESTIGATION OF CASES

General Remarks.—The signs and symptoms of mandibular joint dysfunction are quite varied and often liable to misinterpretation. In the investigation of these cases, more than in any other, a systematic approach to the diagnosis is essential. It is perhaps superfluous to point out that a preliminary routine examination to exclude purely dental causes should be made.

By means of clinical and roentgenographic examinations, such conditions as caries, unerupted and impacted teeth, buried roots, and diseases of the periodontal tissues can be excluded. Certain of the symptoms may make it necessary to exclude sinusitis or other disorders which would warrant referral for ear, nose, and throat examination. The cooperation of the neurologist may also be sought.

Investigation includes clinical and roentgenologic examination and a careful case history. The importance of the latter cannot be exaggerated, since the

significance of many of the incidents or factors responsible for mandibular joint dysfunction is not apparent to the patient and information regarding them is seldom volunteered.

Recording of Case History.—A standard form upon which the clinical and roentgenographic findings and case histories can be recorded is essential, and quite early in this investigation such a form was evolved.

The information obtained is recorded under the following headings:

Name and address
Age, sex, and occupation
Present complaint
Previous history

Pain:

Nature, duration, stimulus required (if any), area(s) affected
Clicking
Stiffness/mobility and extent of opening
Deviation and other eccentric movements
Dentition and occlusion
Neuromuscular tensions
History of trauma
Rheumatic history
Roentgenographic examination
Other details

Finally, provision is made for recording the diagnosis arrived at with an assessment of the primary and contributory etiological factors and the proposed course of treatment. An analysis of the findings in the 186 cases of mandibular joint dysfunction can conveniently be considered under these headings.

Age, sex, and occupation: The age and sex incidence is detailed in Table I.

TABLE I. AGE AND SEX INCIDENCE

AGE (YEARS)	SEX		TOTAL
	FEMALE	MALE	
Under 10	1	–	1
11 to 20	28	6	34
21 to 30	48	19	67
31 to 40	27	9	36
41 to 50	20	4	24
51 to 60	14	1	15
Over 60	9	–	9
Totals	147	39	186

It will be seen that all but a few of the patients are below middle age and that a substantial proportion are in the 20- to 30-year age group.

The female–male ratio is 3.75 to 1, which agrees substantially with the findings of Walsh,[28] Staz,[23] and Hankey,[10] who reported female–male ratios of 4 to 1, 2.5 to 1, and 3 to 1, respectively.

Sixty-nine of the patients were housewives with no outside occupation; a large number of them had young families. A detailed analysis of the occupations of the remaining 117 patients would be very difficult, in view of the variety of occupations involved, but it has been possible to divide them into two categories:

1. Professional, clerical, and students (including 37 typists and 18 students)	77
2. Other occupations	40
	117

Interesting points which emerge from these figures are the preponderance of the professional and clerical classes in this series of cases and the relatively large number of these patients engaged in typing.

When the case histories were originally taken, no significant occupational or class incidence was anticipated and the background of those patients who were housewives was not investigated.

If we examine the main causative factors in mandibular joint dysfunction, it will be seen that:

1. The incidence of malocclusion is unlikely to be significantly different in the two occupational categories unless it is postulated that those patients in category 1 are more likely to have regular dental treatment and, therefore, are less likely to have malocclusion.
2. The incidence of trauma should be expected to be evenly distributed.
3. Only neuromuscular tension may conceivably be more prevalent in category 1 than in the (presumably) more phlegmatic type of patient in category 2, whose occupation in any case possibly carries less responsibility and worry.

It has already been suggested[4] that the preponderance of females suffering from mandibular joint dysfunction may be attributed to a greater tendency to neuromuscular tension in this sex.

This is a field in which the dental surgeon and the psychologist might well cooperate in further research.

Present complaint and previous history: In this preliminary part of the investigation the object is to obtain the patient's own account of symptoms, more detailed information being obtained under subsequent headings.

The symptoms which the patients regarded as their principal complaint are recorded in Table II.

TABLE II. PRINCIPAL COMPLAINTS

COMPLAINT	NUMBER OF CASES	PERCENTAGE OF TOTAL CASES EXAMINED
Pain	152	81.5
Clicking	22	12.0
Limitation of movement	8	4.5
Recurrent dislocation	4	2.0
Totals	186	100.0

It will be observed that patients were prompted to seek treatment by the presence of one of four main symptoms—pain, clicking, limited movement, and recurrent dislocation—and in an overwhelming majority the main symptom was pain.

Of the 186 patients examined, only two had impairment of hearing and one had tinnitus (symptoms which figured so prominently in Costen's[5-7] work). In all three cases these symptoms were mild and were overshadowed by one or another of the main complaints recorded in Table II. It could not be established in any of these cases that impairment of hearing or tinnitus arose as a result of mandibular joint dysfunction.

Pain: It will be seen from Table II that pain was the principal complaint in 152 (or 81.5 per cent) of the cases, and Table III shows that 165 patients in all experienced painful symptoms.

TABLE III. PATIENTS WITH PAINFUL SYMPTOMS

With clicking	97
Without clicking	68
Total number of cases with pain	165

In many cases clicking had been present for many years before pain was felt, and it was only the onset of painful symptoms which prompted these patients to seek treatment.

Pain was invariably dull and aching in character, with attacks of sharp, stabbing pain on mandibular movements, such as eating, yawning, or perhaps talking. Symptoms were frequently aggravated by cold weather or drafts. Pain sometimes was more noticeable when the patient awoke in the morning, gradually diminishing as the day went on; conversely, in other cases it appeared only with function during the day, increasing in intensity toward evening. The significance of these findings will be discussed under later headings.

The areas affected are shown in Fig. 3. The figures within each area represent the number of cases in which pain was experienced in that area. It will be appreciated that in many cases pain was experienced in more than one area, but it is evident that pain was most frequently felt in the region of the mandibular joint itself, followed by the angle of the jaw and ascending ramus. Only twenty-one patients had earache; when headache was present, the temporal region was most frequently affected.

TABLE IV. PATIENTS WITH CLICKING

Unilateral	83
Bilateral	34
Total number of cases with clicking	117

These findings do not agree with the findings of Grewcock,[9] who states: "Pain is sometimes experienced in the joint itself although more often it is referred as a reflex neuralgia to the ear, the mastoid region and the supra-orbital and infra-orbital areas."

It is significant, from the diagnostic point of view, that in every case in which pain was a symptom it could be elicited or increased in intensity by palpating firmly over the affected joint while the mouth was opened.

Clicking: Clicking is frequently the forerunner of painful symptoms, and the history of clicking, cracking, or grating is often prolonged. Clicking was present in 117 cases and was usually unilateral (Table IV).

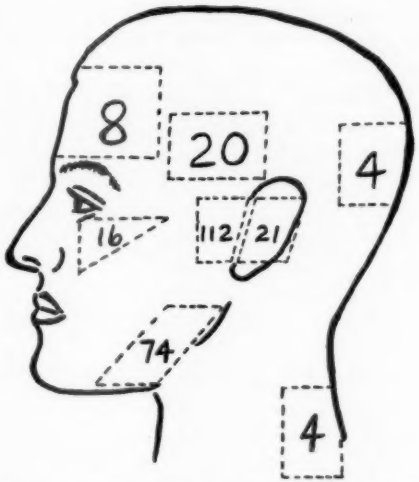


Fig. 3.—Areas in which pain was experienced. The figures within the broken lines indicate the number of patients who experienced pain in that area.

Clicking was considered by the patient to be the principal complaint in only twenty-two (or 12 per cent) of all the cases treated (Table II).

Stiffness or excessive mobility: The extent of mouth-opening was measured in each case by means of a Willis bite gauge. An opening within the range of 3 to 3.5 cm., measured between the incisal edges of the upper and lower incisors, was considered to be normal.

TABLE V. RANGE OF MANDIBULAR MOVEMENT

MOVEMENT	NUMBER OF CASES	PERCENTAGE OF TOTAL NUMBER EXAMINED
Normal	68	36.5
Restricted	82	44.0
Excessive	36	19.5
Totals	186	100.0

Table V shows that in 36.5 per cent of the cases the extent of opening was within normal range; 44 per cent had restricted movement and 19.5 per cent had excessive movement.

Stiffness must be distinguished from trismus arising from causes not directly connected with the mandibular joint. The causes most likely to

be encountered are those associated with infections (particularly around the lower third molar region), and in these cases the history and clinical examination should make the differential diagnosis fairly simple. When trismus is due to spasm of the medial pterygoid muscle following an inferior dental injection, however, diagnosis may be more difficult. Campbell[2] has pointed out that in these cases the mouth opening may be increased slightly if the jaw is deviated to the unaffected side. This brings the lower attachment of the muscle into a position directly beneath the upper attachment and although no relaxation of the muscle takes place, the vertical direction of its fibers allows a slight increase in the separation of the jaws. The relaxation of the opposite medial pterygoid muscle necessary to allow the jaw to deviate can take place, since this muscle is not in spasm. These facts may be utilized in the diagnosis of trismus arising from medial pterygoid spasm as distinct from limitation arising from mandibular joint dysfunction.

Stiffness is frequently a protective mechanism to avoid movements which will give rise to pain in the joint. It may be more marked at certain times of the day. Stiffness experienced on awakening in the morning and gradually diminishing as the day progresses is invariably found in cases in which muscle tensions with such manifestations as bruxism have been active during sleep and is also a characteristic finding in cases of rheumatoid arthritis.

Excessive movement is invariably accompanied by clicking, which is frequently painful. Clicking usually occurs at the end of the normal extent of opening and again as the condyle passes back through this position in the closing movement. It is probably caused by the condyle passing over the anterior edge of the articular disc when the synchronous movements of condyle and disc are disturbed.

Painful clicking is particularly marked in severe cases in which recurrent subluxation or recurrent forward dislocation may occur. In recurrent subluxation the patient may have some difficulty in returning the condyle to the glenoid fossa after excessive opening. If dislocation occurs, the condyle not only passes beyond the anterior limits of the articular tubercle but is impacted in the infratemporal fossa in front of the tubercle and cannot return to the glenoid cavity until the dislocation has been reduced. If the dislocation is unilateral, the jaw will be deviated to the unaffected side. Palpation over the dislocated joint will reveal a depression in the space normally occupied by the condyle.

It was found that although excessive or restricted movement was demonstrated, this was seldom the patient's principal complaint. Table II shows that limitation of movement was the principal complaint in only eight patients (4.5 per cent), and excessive movement was the chief complaint in four (2 per cent) in whom movement was so excessive that it resulted in recurrent dislocation.

Deviation and other eccentric movements: The most frequent eccentric mandibular movement found in joint dysfunction is deviation of the mandible on opening. This occurs when condylar movement is unequal; the jaw will then deviate to the side where movement is more limited. Deviation will

also occur when there is unilateral condylar hyperplasia or when there is a tumor of the condyle. In these cases there is usually noticeable asymmetry of the face associated with deviation to the normal side when the mouth is closed, and this is accentuated on opening. Unilateral condylar hypoplasia also gives rise to mandibular deviation, the jaw deviating to the affected side. Roentgenographic examination in these cases is very informative and should include anteroposterior views which will allow comparison of the lengths of the ascending rami.

A.

B.

Fig. 4.—*A*, Occlusal irregularity. The upper left lateral incisor is out of alignment and occluding inside the lower arch.
B, Deviation of the mandible to the left as a result of the above malocclusion.

A variety of other eccentric movements may occur as a result of faulty occlusion. A tooth in premature contact or out of alignment can guide the mandible into an eccentric closure with deviation in a lateral or anteroposterior direction (Fig. 4). A reversal of the process occurs when the mouth is opened and the mandible can be observed to swing back to a central path during the opening movement.

Another example of eccentric movement is seen in the Class II, Division 2 (Angle) type of occlusion when the mandible is guided into a retrusive position

by the linguoclination of the upper incisors; in severe cases the opening movement takes the form of two distinct arcs. The first arc of the movement has its convexity toward the inside of the mouth, the patient being forced to adopt this eccentric initial opening movement in order to carry the lower incisors clear of the upper incisors. The second arc is the reverse of the first and completes the opening movement. The two arcs together form the shape of the letter *S*. Fig. 5 illustrates the occlusion of a patient who had adopted this type of eccentric movement.

Eccentric movement may also occur as a result of changes in the joint itself. Clicking of the joint is frequently accompanied by a marked interruption or "jump" in the smooth mandibular movement, which is probably caused by the condyle slipping over the anterior edge of the disc.

Fig. 5.—Overclosure with linguoclination of upper incisors.

Similar manifestations may be observed in chronic degenerative joint lesions when degenerative changes have given rise to deformity of the condylar or temporal component of the articulation. Deformity may be in the nature of a flattening of the articular surfaces due to erosion, or in more advanced stages proliferative changes with "lipping" of the margins of the condyle may occur. These changes in the articular surfaces result in mechanical obstruction to the smooth functional relationship of the two components, and eccentric mandibular movement is the clinical manifestation which can be observed. In many cases a degree of adaptation of the articular bones to each other eventually takes place, but eccentric mandibular movement usually persists.[29]

Dentition and occlusion: An analysis of the dentitions and types of occlusion found in this series is given in Table VI.

A high percentage (68 per cent) had natural dentitions, and in almost one-half the total number of cases (42 per cent) no abnormality could be found in the occlusion.

In 14.5 per cent of the patients the jaws were found to be overclosed. Clinical examination to confirm overclosure included a measurement taken between the base of the nasal septum and the lower border of the symphysis

menti by means of a Willis bite gauge while the teeth were occluded and again while the mandible was at rest. The difference between these readings was then assumed to be the free-way space existing between the upper and lower teeth while the jaw is at rest. Any increase in the free-way space beyond the normally accepted limits was taken as an indication of overclosure.

TABLE VI. DENTITION AND OCCLUSION

	OCCLUSION						
DENTITION	A NORMAL OCCLUSION	B OVER-CLOSURE	C OVEREX-TENSION	D LOSS OF MOLAR SUPPORT	E OCCLUSAL IRREGULAR-ITIES EX-CLUDING A, B, C, AND D	TOTAL	PERCENT-AGE OF TOTAL CASES EX-AMINED
1. Natural dentition only	60	12		11	43	126	68.0
2. Partial denture	14	3		7	5	29	15.5
3. Full upper and lower dentures	15	8	4			27	14.5
4. Edentulous		4				4	2.0
Total	89	27	4	18	48	186	100.0
Percentage	48.0	14.5	2.0	9.5	26.0	100	

Although this procedure, an accepted method of measuring the interocclusal free-way space, was used in the investigation of these cases as a guide, little reliance was placed upon the measurements obtained for the following reasons:

1. It was found to be extremely difficult to establish the rest position of the mandible with any confidence in its accuracy.

2. Even assuming that the rest position was accurately recorded, the acceptable normal limits of the free-way space are subject to so much variation that there is great difficulty in deciding whether or not it is excessive for an individual patient. (Landa[12] has found the interocclusal free-way space to vary from 1 to 8 mm., and wider variations have been expressed by other authors.)

Overclosure is indicated by other means which, although empirical, have been found to be valuable aids. A comparison of the middle and lower thirds of the face will reveal a foreshortening of the lower third in conditions of overclosure, and this foreshortening can be confirmed by comparing the measurement taken between the pupil of the eye and the corner of the mouth with that taken between the base of the nasal septum and the lower border of the symphysis menti. This appearance is usually accompanied by a jutting forward of the lower jaw.

The presence of angular cheilosis or fissuring at the corners of the mouth may also be evidence of overclosure. The fissures tend to slope downward

and outward from the corners of the mouth and must be distinguished from fissuring as a result of certain vitamin B deficiencies which tend to radiate outward in a more horizontal direction.[3] The two conditions are illustrated in Fig. 6.

The reactions of the patient when layers of wax are interposed between the occlusal surfaces of the upper and lower teeth are also of value in confirming overclosure. The patient with overclosure will experience a feeling of added comfort when the bite is raised temporarily in this way.

A.

B.

Fig. 6.—*A*, Angular cheilosis resulting from overclosure. The fissures slope downward and outward.
B, Angular cheilosis in vitamin B deficiency. The fissures are horizontal.

In view of the difficulties of obtaining an accurate roentgenographic view of the condyle–glenoid fossa relationship, roentgenographic evidence of posterosuperior displacement of the condyle was accepted with a certain amount of reservation.

Overextension was diagnosed in four patients (2 per cent). Although in severe cases the facial appearance may furnish evidence of overextension, such symptoms as muscle pain and tiredness which are relieved when the dentures are removed are more reliable diagnostic features. If a patient who has worn dentures for many years complains of these symptoms when new dentures are inserted, overextension should be suspected.

Loss of molar support (which accounted for 9.5 per cent of the cases) is obvious in patients who have natural dentitions with missing molars. The condition may be unilateral or bilateral, and upper or lower molars (or both) may be missing. This condition is also found when partial dentures have been worn for some time and have not been designed to prevent "sinking" of the denture with associated lack of molar occlusion.

The majority of cases in which malocclusion was found had occlusal irregularities other than those already discussed. These cases amounted to 26 per cent of the total number examined. Occlusal irregularities varied from an individual tooth or cusp in premature contact guiding the mandible into an eccentric closure or a tooth out of alignment interfering with lateral or protrusive excursions of the mandible to more widespread mutilations presenting a formidable problem in treatment.

Extraction of teeth without replacement is often a cause of occlusal irregularity, as it results in drifting or tilting of adjoining teeth into the space created by the extraction and elongation of teeth in the opposing jaw. Crowding also results in irregularities when teeth are forced out of the arch or when imbrication of the incisors occurs. These cases often present severe widespread mutilation of the occlusion which is extremely difficult to correct.

A distinction is usually made between the terms "premature contact" and "initial contact." Thompson[25] distinguishes between the two by the fact that in premature contact certain teeth meet before the mandible has completed its normal interocclusal clearance, whereas in initial contact the mandible has completed its normal path of closure when the offending teeth meet and it is then directed into an abnormal path of closure. Initial contact would appear to be, in fact, analogous to overclosure; in the present series of cases it has been regarded as such and treated accordingly.

It is emphasized at this point that, although malocclusions were found to be present, they were not always considered to be primarily responsible for mandibular joint dysfunction. Indeed, severe malocclusion may exist for many years without giving rise to any mandibular joint symptoms. Fig. 7 illustrates one of the many cases which may be found to emphasize this fact.

Neuromuscular tension: Seventy-four patients exhibited manifestations of neuromuscular tension in one form or another, and in fifty-nine cases (31.75 per cent of the total number of cases examined) muscle tension was considered to be the primary etiological factor in mandibular joint dysfunction.

Manifestations of muscle tension may take a variety of forms. The most common is bruxism, but clenching of the teeth and other habit patterns are very often indulged in when the patient is under stress. The violence of muscle contraction may be considerable, a fact which is well illustrated by the words of one of these patients who stated that she had dreams in which she "seemed to be crunching [her] teeth to powder."

Stress and anxiety may be associated with the patient's occupation or home worries and are often found to occur in association with activities requiring concentration, such as driving a car. Muscle tension with accompanying mandibular joint dysfunction has been observed in patients in the weeks prior to

or following important events, such as weddings (in which the patient has a personal interest) or examinations. This is illustrated by the case histories of six young students included in this series who had developed muscle tension before taking important examinations. The tensions and the accompanying symptoms of mandibular joint dysfunction disappeared shortly after completion of the examinations.

It is felt also that certain occupations with exacting physical as well as mental requirements would predispose to muscle tensions. Typing, with its continuous rapid precise action, would come into this category and would predispose to abnormal muscle tension in a person whose neuromuscular mechanism is easily disturbed by external stimuli.

Fig. 7.—Severe malocclusion without mandibular joint symptoms. The teeth interdigitate rather than occlude. This patient had lost his posterior teeth twenty years previously.

Tishler,[26] discussing occlusal habit neuroses, states: "Dental practitioners realize that the psychic balance of their patients is strikingly unlike. In some cases it is easily upset and patients become almost hysterical on the slightest provocation while the nervous equilibrium of others is well under control. Between these extremes is a varying degree of psychic response and it is the first group of patients who readily form habit neuroses of all kinds."

Tishler has also noted that a large percentage of patients whose normal psychic impulses are easily unbalanced develop the habit of grinding or clenching the teeth in response to discomfort caused by traumatic occlusion. This is undoubtedly true, and a large number of patients in this series had occlusal defects in addition to manifestations of neuromuscular tension. Frequently, difficulty was experienced in deciding which of these two factors was the primary cause of joint dysfunction when they were both found in the same patient, and treatment of malocclusion was always instituted with a diagnostic as well as a curative aim.

Underlying emotional tension was implicated by Miller and Firestone,[14] who were interested in psychosomatic factors in the etiology of periodontal

disease. They state: "Emotional tension may create oral disease through a disturbance of the physiology, that is, bruxism due to an unrealized aggression."

It must not be imagined from the foregoing remarks that patients who show manifestations of neuromuscular tension are all neurotic individuals exhibiting outward signs of a disturbed personality. With one or two exceptions, all the patients examined have been, to all intents and purposes, entirely normal persons.

Patients may be unaware of the existence of muscle tensions, and in any case they normally regard clenching or grinding the teeth as being quite unconnected with their complaints. Information concerning such activities is therefore seldom volunteered at the time of the initial examination. Grinding or clenching may be sufficiently pronounced to be noticed by another member of the patient's family, however, and this fact is very often disclosed at a subsequent visit.

Fig. 8.—Attrition of the teeth in a case of bruxism.

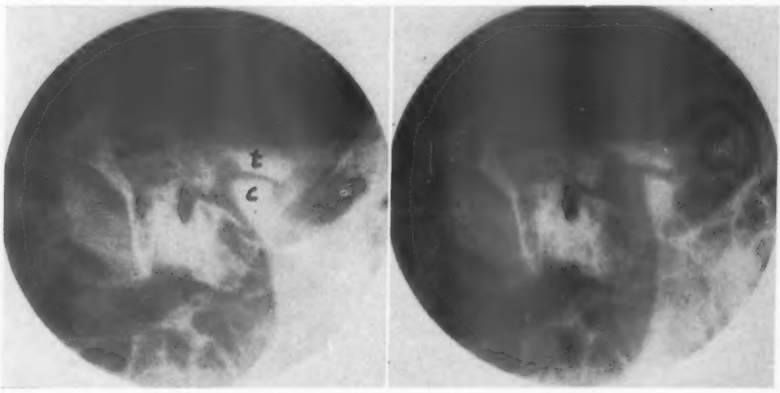
The existence of neuromuscular tensions, particularly bruxism, may be confirmed in many cases by an examination of the teeth. Continuous grinding causes attrition of the occlusal surfaces of the teeth and, although the whole dentition may be involved (Fig. 8), it is more usual to find the pattern of attrition more marked in the anterior teeth and in particular the upper canines, the cusps of which may be worn flat.

Neurotic activity of the masticatory muscles is often accompanied by other neurotic manifestations, such as nail-biting, and an examination of the fingernails is frequently informative. Pain and stiffness on awaking in the morning can be taken as further evidence of muscle hyperactivity during the night.

Neuromuscular tension of long standing, in common with uncorrected malocclusion, may give rise to degenerative changes in the joint. These changes are described by Weinmann and Sicher.[29] In the early stages the connective tissue covering the articular surfaces becomes irregular and shows signs of proliferation and of degeneration. In the second stage these changes are exaggerated. In the third stage the bone of the condyle and articular eminence is exposed, and much of the articular bone may be lost by erosion so that the surfaces become flattened. The eccentric mandibular movements which follow

upon these changes have already been described. Fig. 9 shows the roentgenographic appearance of a joint which has undergone these degenerative changes as a result of long-standing neuromuscular tension.

It is interesting to note that the female–male distribution in the seventy-four cases of neuromuscular tension was 62 to 12 (approximately 5 to 1), which is slightly higher than the over-all figure (3.75 to 1).



A. *B.*

Fig. 9.—Roengenograms show advanced degenerative changes in the condylar and temporal components of the mandibular joint as a result of long-standing neuromuscular tension. Erosion has resulted in a flattening of the articular surfaces of both the condyle and the glenoid tubercle. *c*, Condyle; *t*, glenoid tubercle. *A*, Mouth closed. *B*, Mouth open.

Trauma: Forty-two patients gave a history of trauma prior to the onset of symptoms. Traumatic factors include blows on the jaw, injuries sustained at games, difficult dental extractions, prolonged dental treatment, biting unexpectedly on hard objects, yawning, coughing, or laughing.

When there is a history of trauma, the possibility of fracture must be borne in mind and the investigation should include examination to exclude this condition. The signs of fracture of the neck of the condyle include the following:

1. Displacement of the mandible to the injured side due to the pull of the elevator muscles and gagging on the last molars of the affected side.
2. The lateral displacement is increased on opening.
3. Palpation reveals no movement of condyle on opening the mouth.
4. Roentgenograms (particularly anteroposterior views taken in the occipitofrontal position) will reveal the fracture and possibly displacement of the condyle head.
5. There is pain on movement of the jaw, and swelling and tenderness are present over the injured joint (which may obscure many of the signs of fracture).

There may be an associated fracture of the body of the mandible.

Apart from the possibility of fracture, trauma to the mandibular joint may result in either contusion or strain.

Contusion usually results from a direct blow on the lower jaw or on the joint itself. In the early acute stages there is limited motion due to pain, which is increased when an attempt is made to open the mouth. Frequently in these cases the structures of the joint escape permanent injury and there are no residual symptoms.

Strain results from forced excessive opening of the mouth. Strain usually follows a dislocation of the jaw, and the traumatic factors involved are those likely to give rise to dislocation, such as overenthusiastic use of a mouth gag, difficult extractions, or yawning. The acute symptoms of joint strain are similar to those arising from contusion, but they are likely to be more severe. Since there is associated stretching or tearing of the joint ligaments, there is a greater likelihood of permanent damage; consequently, such residual symptoms as clicking or recurrent subluxation accompanied by pain may persist after the acute symptoms have subsided.

Although there may be reliable evidence of trauma, other etiological factors must not be overlooked. A joint already weakened by other factors is undoubtedly more susceptible to trauma.

In six of the forty-two cases with a history of trauma, the traumatic incident was trivial enough to be considered a contributory rather than a primary factor in the etiology of joint dysfunction. In the remaining thirty-six cases (19.5 per cent of the total number of cases in this series) trauma was considered to be the primary etiological factor.

Rheumatic history: Hollander[11] states: "Involvement of the articulation of the jaw is rather common in rheumatoid arthritis. On palpation both tenderness and crepitation on motion may be felt. . . . Clicking jaw may result from trauma or may follow inflammatory change. The trauma may be minimal—such as a strain from sleeping with a pillow pressing the jaw to one side."

Russell and Bayles[17] found the mandibular joint involved in fifty-one out of 100 rheumatoid arthritis cases examined. These figures indicate that rheumatoid arthritis probably attacks the mandibular joint more frequently than is generally supposed.

The disease usually has an insidious onset in persons between the ages of 20 and 45 years and affects about three women to each man. Joint involvement is characteristically symmetrical and most commonly affects the peripheral joints, especially the proximal interphalangeal joints.

Periods of exacerbation and remission frequently occur, and pain, heat, and swelling of the periarticular tissues are present. Morning stiffness is a marked feature, and in acute stages movement is extremely limited and painful.

Roentgenographic examination may be negative in early mild lesions, but later there may be progressive narrowing of the joint space and irregular erosion of the bone on the articular surfaces, as illustrated in Fig. 10.

Rheumatoid arthritis may vary from a mild atypical form with asymmetrical joint involvement and frequent lengthy periods of remission to the progressive crippling form leading to severe disability and deformity. Collins[3] considers that all forms are varieties of the same morbid process.

A.

B.

Fig. 10.—*A*, Mandibular joint roentgenograms of a case of chronic rheumatoid arthritis. There is some degree of erosion of the articular surfaces of the condyle and glenoid fossa with marked limitation of movement. *Left*, Mouth closed. *Right*, Mouth open.

B, Deformity of the peripheral joints (particularly the metacarpophalangeal joints) in the same case.

In this investigation nineteen cases (10.25 per cent) were diagnosed as rheumatoid arthritis in one or another of its forms. Other joints (usually the small peripheral joints) were involved in all these cases, and some of the patients also complained of muscular rheumatism affecting mainly the muscles of the neck and shoulders. The majority were being treated or had undergone treatment for arthritis affecting the other joints, and five of the patients had the

progressive crippling form of the disease. In all but three of the nineteen cases other traumatogenic factors, such as malocclusion, neuromuscular tension, or extrinsic trauma, were also present.

ETIOLOGICAL FACTORS

In the majority of cases, selection of the methods of treatment to be employed depends largely on the factors considered responsible for mandibular joint dysfunction. When more than one etiological factor is concerned, it is sometimes difficult to establish which is primarily responsible and which is contributory.

The etiological factors, together with the number of cases in which each factor was considered primarily responsible for dysfunction, are recorded in Table VII. The number of cases in which each factor played a contributory part is also recorded.

TABLE VII. ETIOLOGICAL FACTORS

ETIOLOGICAL FACTORS	A PRIMARY (NO. OF CASES)	B CONTRIBUTORY (NO. OF CASES)
1. Overclosure	16 (8.5%)	11
2. Loss of molar support	11 (6%)	7
3. Overextension	4 (2%)	—
4. Other occlusal irregularities	32 (17%)	16
5. Trauma	36 (19.5%)	6
6. Neuromuscular tension	59 (31.75%)	15
7. Rheumatoid arthritis	19 (10.25%)	—
8. Hyperthrophy of condyle	2 (1%)	—
	179	
9. Etiology not established	7 (4%)	
Totals	186 (100%)	

Note: When only one etiological factor is present, it is entered in Column A. Where more than one factor is present, the factor considered to be primarily responsible for dysfunction is entered in Column A and the others are shown in Column B.

It will be seen from Table VII that malocclusion of all types (factors 1 to 4) was considered to be the primary factor in sixty-three (33.5 per cent) of the cases, and occlusal irregularities (factor 4) accounted for thirty-two, or one-half, of the cases in this group. It is perhaps surprising that overclosure was not implicated more frequently, since this factor has figured so prominently in the literature.

Neuromuscular tension was responsible for symptoms in fifty-nine (31.75 per cent) of the cases. Malocclusion, particularly of the occlusal irregularity type, frequently gives rise to neuromuscular tension. When both of these factors were present, it was often difficult to decide which was the primary and which the contributory cause of dysfunction. Frequently this question was not decided until it was found that symptoms persisted despite correction of malocclusion and were subsequently relieved when neuromuscular tension was treated.

Trauma accounted for thirty-six (19.5 per cent) of the cases. When a history of trauma was obtained, it was usually considered to be responsible for

symptoms. The nature and severity of the traumatic incident were investigated fully, so that the degree of permanent joint damage and the prognosis could be estimated.

When rheumatoid arthritis was diagnosed, even in its milder forms, it was considered to be the primary factor. Although in all but three of the nineteen cases other etiological factors had to be treated, these factors were considered contributory in that they rendered the joint more susceptible to arthritic involvement.

Hypertrophy of the condyle is a rather rare condition, and although there is derangement of the occlusion, it does not always give rise to mandibular joint symptoms. The number of cases encountered is, therefore, small.

In seven cases the common etiological factors were excluded and the etiology could not be established. These cases responded to empirical treatment, although the etiology remained obscure.

NOTES ON DIFFERENTIAL DIAGNOSIS

A considerable amount of what has been written in the preceding pages has been concerned with the methods of establishing a diagnosis of mandibular joint dysfunction.

It has been pointed out that the signs and symptoms fall into four main categories: (1) pain, (2) clicking, (3) limited movement, and (4) excessive movement.

Of these, pain and limited movement or trismus are the two symptoms most likely to give rise to difficulty in the differential diagnosis.

In most of the referred cases mistakenly diagnosed as mandibular joint dysfunction, the correct diagnosis was quickly apparent on routine clinical examination. Fourteen of these cases presented some initial difficulty, however, and they are discussed briefly now to illustrate some aspects of differential diagnosis.

In five cases the diagnosis of impacted lower third molars was made. In each case the patient complained of pain in the mandibular joint area with trismus and increased pain on moving the mandible. Clinical dental examination revealed varying degrees of malocclusion but was otherwise negative, and roentgenograms revealed deeply placed impacted lower third molars which appeared in each case to be in a position unlikely to give rise to pressure symptoms. There was no evidence of infection. On the basis of these facts, together with the nature of the pain and trismus, a provisional diagnosis of mandibular joint dysfunction was made, although removal of the impacted teeth was also arranged. In the interim, symptoms failed to respond to physiotherapy but were relieved completely after operation.

Four cases were referred with trismus following the extraction of lower molar teeth under inferior dental block anesthesia. Clinical and roentgenographic examination failed to establish the cause of symptoms, and a traumatic joint lesion as a result of the extractions was excluded in the absence of pain and tenderness in the joint. Diagnosis of spasm of the medial pterygoid muscle

was made in the light of the history of injection and the fact that the mouth opening could be increased slightly on deviation to the unaffected side, as already discussed.[2]

In one case there was trismus with no apparent cause. Pain distributed over the angle of the jaw and mandibular joint region was increased on movement of the jaw. Roentgenograms revealed recurrent caries under a filling in a lower molar tooth. Extraction of the tooth relieved both pain and trismus. It is known that pain arising from the teeth leads to reflex muscle spasm of the temporal and masseter muscles, as pointed out by Wyke[30] and others who were able to obtain muscle relaxation by injecting local anesthetics around the affected teeth. There is little doubt that this is the explanation of symptoms in the above case; the patient might have been subjected to lengthy, ineffectual treatment for mandibular joint dysfunction if a careful clinical and roentgenographic examination had not been made.

In two cases of trigeminal neuralgia the correct diagnosis was missed in the early stages. In both cases pain was precipitated by movement of the mandible; as both patients had full upper and lower dentures with mandibular overclosure, it was felt that posterior-superior displacement of the condyle might well be responsible. Treatment designed to increase vertical dimensions was unsuccessful, and it became evident as the attacks became more severe and paroxysmal in nature that a diagnosis of trigeminal neuralgia should be made.

Two cases referred as mandibular joint dysfunction cases were diagnosed as carcinomas of the nasopharynx. The gravity of this condition demands a prompt diagnosis, and some of the symptoms resemble those of mandibular joint dysfunction so closely that there is a real danger of mistaken diagnosis with resulting delay in institution of appropriate treatment.

Trotter[27] described a group of signs and symptoms arising from a tumor of the nasopharynx. The syndrome which bears his name includes pain distributed over the mandible, side of the head, tongue, and ear, impairment of hearing, asymmetry of the soft palate, and trismus. The tumor arises in the pharyngeal wall; impairment of hearing is due to invasion of the eustachian tube, and derangement of the soft palate and trismus result from involvement of the muscles of the soft palate and the medial pterygoid muscle, respectively. The mandibular nerve is subjected to pressure from the tumor in the region of the foramen ovale, and further extension into the skull may also involve the maxillary division of the trigeminal nerve. Anesthesia in the distribution of these nerves may be a later manifestation.

Both of the cases discussed here involved male patients aged 16 and 22 years, respectively. The initial symptoms of trismus and unilateral facial pain were indicative of mandibular joint dysfunction; this diagnosis was strengthened by the fact that, by an unfortunate coincidence, both patients had suffered trauma to the mandible prior to the onset of symptoms. Trismus and pain became worse in spite of treatment, and anesthesia developed in the distribution of the mandibular division in one case and the mandibular and maxillary divisions in the other after approximately two months had elapsed. It was only then that a tumor of the nasopharynx was suspected and appropriate treatment instituted.

Trotter described the clinical picture as "singularly liable to give rise to errors in diagnosis," and this is well illustrated in the two preceding cases. Although comparatively rare, these tumors should be constantly borne in mind in the differential diagnosis of mandibular joint dysfunction and, indeed, in any case of facial pain.

Tumors of the condyle itself may give rise to mandibular joint dysfunction, although they also are comparatively rare. Chondromas and osteomas are most commonly found in this position,[24] and metastatic tumors also have been reported. These should not escape recognition on roentgenographic examination, which should include anteroposterior views (in the occipitofrontal position) in addition to lateral oblique views if there is any doubt.

SUMMARY

The material used in this investigation has consisted mainly of 186 cases examined and treated by me.

The case histories and the results of clinical and roentgenographic examinations are recorded on a standard form, and an analysis of the findings indicates that female patients, particularly in the 20- to 30-year age group, predominate. In the majority of cases pain is the symptom which prompts the patient to seek treatment, and pain is most frequently experienced in the region of the joint itself.

Malocclusion in one form or another was found in approximately one-half of the patients, but only a small proportion of these had overclosure. Although malocclusion was present in these cases, it was frequently considered a contributory rather than a primary etiological factor.

Neuromuscular tension and trauma were frequently responsible for mandibular joint dysfunction. Rheumatoid arthritis, varying from mild atypical forms to the progressive crippling form, probably attacks the mandibular joint more often than is generally supposed, although there are usually accompanying etiological factors which render the joint more susceptible to rheumatic involvement.

Etiological factors are placed as far as possible into primary and contributory categories. In most cases methods of treatment to be employed depend upon the factors considered responsible for symptoms.

The differential diagnosis of mandibular joint dysfunction is made easier by the use of a standard form for recording case histories and clinical findings. Certain conditions which may present difficulties in differential diagnosis are discussed.

I am very much indebted to Professor T. Talmage Read for his interest, encouragement, and advice during this investigation and to Mr. L. Jepson for the photographs and photomicrographs.

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ENDODONTICS

The American Association of Endodontists

Captain Warren J. Hedman, Editor

EVALUATION OF A METHOD TO DETERMINE THE PRESENCE OF A FOCUS OF INFECTION

Preliminary Report

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VARIOUS tests have been used for diagnosing the presence of a focus of infection. Among them may be named the Schilling or Arneth count,[1] in which an increase in the number of young polymorphonuclear leukocytes is interpreted as an indication of the presence of a focus of infection. The blood sedimentation rate is another method of determining whether or not infection is present, rapid settling of the red blood cells being indicative of a positive reaction.[2] No direct relationship between the presence of x-ray-positive or x-ray-negative teeth and the blood sedimentation rate was found by Rault.[3]

In a number of pulpless-tooth cases in which the Weltmann serum coagulation test was performed by Aronson and Grossman,[4] no correlation was found regardless of the presence or absence of areas of rarefaction. Also, provocation of an area of rarefaction associated with a pulpless tooth by means of a high-frequency current, followed by a blood sedimentation rate test, as suggested by Gutzeit[5] and others, has led to no definite correlation. The skin test has been used by Kauffer,[6] Prader,[7] and Dietz.[8] Kauffer's test was based on the Dick test, and he found that less than 20 per cent of cases with foci of infection gave a positive reaction. Prader prepared a vaccine from microorganisms isolated from the root canal, injected a minute amount intracutaneously, and then photographed the reaction forty-eight hours later under normal and infrared light. His results were inconclusive. Dietz found almost as many positive skin reactions regardless of whether or not bacteria were demonstrated in the pulp-involved group.

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The present study was suggested by the work of Okell and Elliott,[9] who found that a transient bacteremia followed the extraction of loose or pyorrhetic teeth in a relatively high percentage of cases, and by the work of Round and associates,[10] who found that cases in which there was marked periodontal involvement the simple chewing of hard candy also produced a transient bacteremia. Apparently, the intermittent trauma of chewing was sufficient to release microorganisms from the gingival sulcus and to force them into the blood stream. It was believed, therefore, that if an infected, untreated pulpless tooth with an area of rarefaction were traumatized, microorganisms should be released from the root canal into the periapical tissue, where they would enter the circulation and thus produce a transient bacteremia. If this should be true, then any treated pulpless tooth could be traumatized similarly, and, if microorganisms were cultured from the blood stream, it could be deduced that such a tooth was acting as a focus of infection.

METHOD

A preoperative sample of blood was obtained from the median basilic vein of the arm, and 7 ml. of blood was placed in two flasks. Each contained 40 ml. of brain-heart infusion broth with 0.1 per cent agar. In addition, one of these flasks contained 0.03 per cent sodium polyanethol sulfonate (Liquoid) with the object of neutralizing the potential antibacterial effect of the leukocytes. As the study progressed, Difco heart infusion broth instead of Difco brain-heart infusion broth was used, as it was considered superior to the latter for growing microorganisms present in blood.

A pulpless tooth with an area of rarefaction was then vibrated by means of a Hollenback pneumatic condenser equipped with a rubber tip. The tip was placed against the labial surface of the tooth near the incisal edge, the vibrator was turned on at the maximum speed, and the tooth was vibrated both laterally and axially for one minute. The object of this procedure was to release microorganisms from the root canal, disseminating them into the periapical tissue and blood stream.

Immediately afterward, within fifteen to sixty seconds, a postoperative sample of 7 ml. of blood was obtained and distributed equally into two additional flasks of culture media, as described above. The amount of blood taken postoperatively was increased to 20 ml. after the first seventeen cases. All four flasks were labeled and incubated aerobically at 37° C. Cultures were examined for growth daily for ten days.

In order to rule out the possibility that any microorganisms cultured from the blood samples came from the periodontal tissue rather than the root canal, the gingiva near the pulpless tooth was swabbed with a twenty-four-hour suspension of *Serratia marcescens* as a test organism.

Immediately after the postoperative blood was obtained for culturing, the root canal was opened under aseptic conditions and two cultures were taken in brain-heart infusion broth (Difco) with 0.1 per cent Bacto agar. These cultures

were incubated aerobically and anaerobically at 37° C. and were used as controls to indicate whether or not microorganisms were present in the canal. Obviously, if none were present we could not expect to find them in the blood stream after vibrating or traumatizing the tooth.

RESULTS

Thirty-one teeth were subjected to the procedure. Of this number, only sixteen yielded positive cultures from the root canal. The microorganisms cultured were those generally isolated from root canals, primarily alpha streptococci and staphylococci. All preoperative blood cultures were negative, and all postoperative blood cultures were negative.

DISCUSSION

In view of the fact that all postoperative blood cultures were negative, certain questions arose. Did the vibration produce enough trauma to force some microorganisms out of the root canal, when present? Was the culture medium adequate for growing the microorganisms? Were there enough microorganisms present in the blood sample for growth? Was the amount of blood in a sample adequate? Was the ratio of blood to culture medium sufficient? It was thought that some indication of a response, if not an altogether complete answer, to these questions might be given (a) if the root canal itself were subjected to instrumentation with reamers and files rather than simply vibrating the tooth and (b) if periodontally involved teeth were vibrated. In both cases, postoperative cultures would be taken to determine whether or not a transient bacteremia had resulted.

In thirty-one additional cases blood cultures were taken immediately before and immediately after instrumentation of the root canal of a pulpless tooth with an area of rarefaction under the usual clinical conditions following a standard technique.[11] The root canals yielded growth in twenty-one cases prior to instrumentation. In this series, all preoperative cultures were negative, but one postoperative blood culture was positive. In this case a diphtheroid bacillus was recovered from both the root canal and the blood culture. This would seem to indicate (1) that a bacteremia does not ordinarily occur during instrumentation of a root canal but that there is always a possibility that it might occur, (2) that there are usually not enough microorganisms forced out of the root canal into the blood stream, or (3) that the blood sample is inadequate. In view of the fact that 20 ml. of blood was taken and divided equally into two flasks, one with and the other without Liquoid, and because this amount of blood (or even less) is usually used for blood cultures, it is likely that the blood sample was not inadequate but rather that the number of microorganisms, if present, was too small.

In another series of cases, in order to determine whether the vibrating method used in this study to release microorganisms was effective, teeth with a marked periodontal condition were vibrated in nine cases, blood cultures being made before and after vibration. In all nine cases, both preoperative and postoperative cultures were negative.

SUMMARY

In this preliminary study, an effort was made to explore a method for determining whether or not a focus of infection is present by vibrating a pulpless tooth that has an area of rarefaction, with the object of releasing microorganisms into the blood stream. In thirty-one cases in which this was done, both preoperative and postoperative cultures were negative.

In thirty-one additional cases in which instrumentation of the root canal following a standard technique was carried out, preoperative cultures were negative but in one case the postoperative culture was positive. The same microorganism was recovered from both the root canal and the blood stream.

In nine cases of marked periodontal disease in which the involved teeth were vibrated, both preoperative and postoperative blood cultures were negative.

CONCLUSION

On the basis of the cases reported here, it may be concluded that vibrating a pulpless tooth is not an adequate means for disseminating microorganisms into the blood stream in order to determine whether or not the tooth is acting as a focus of infection.

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ARMED FORCES AND PUBLIC HEALTH SERVICE

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STUDIES ON PERIODONTAL DISEASE IN THE MOUSE

III. The Germ-Free Mouse and Its Conventional Control

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IN A recent publication from our laboratory, we reported the occurrence of periodontal disease in germ-free white Swiss mice.[1] The present report will describe the disease, both grossly and histologically, as it is found not only in the germ-free mouse but also in controls raised conventionally.

MATERIALS AND METHODS

The maxillary and mandibular jaws and teeth of thirty-eight germ-free white Swiss mice and thirty-one "conventional" control mice were studied. The germ-free animals were drawn from the colony maintained in the Laboratory of Germfree Animal Research, National Institute of Allergy and Infectious Diseases. This colony was established from mice of the colony maintained at the Lobund Institute, University of Notre Dame. Their colony was started in 1954 from Swiss-Webster mice.[2] Two types of controls were used. One group of twenty-six animals was picked at random from a conventional colony established originally from the germ-free mice. The other group of five mice were germ-free for a period of four to five months. Then they were brought out of their germ-free environment and maintained in an animal room for an additional period of two to three months as "conventional" animals. The mice in both groups ranged in age from 39 days to more than 6 months.

The germ-free mice were maintained under sterile conditions in Reyniers Germfree System Units of the 500 Series. They were weaned at the age of 4 weeks and were raised on the diet shown in Table I. Before introduction into

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a germ-free unit, the food was sterilized in the attached autoclave at 255° F. for twenty-five minutes. Prior to sterilization, a vacuum was first drawn on the food, followed by a five-minute application of relatively free-flowing steam. The diet was administered ad libitum to the mice in the form of cakes approximately 2 inches square and 1 inch thick. The prepared cakes are rather hard, but not as hard as the compressed laboratory chow pellets usually fed mice. Sterile water, brought into the units in sealed cans, was available in standard water bottles. Groups of four or five mice were on a sawdust bedding within glass jars. The air entering the units was of constant humidity and temperature and was passed through a spun-glass filtering medium.

TABLE I. COMPOSITION OF MOUSE DIET*

INGREDIENT	QUANTITY PER KILOGRAM OF DIET
Salt mixture W (plus 0.33% zinc carbonate)	50 Gm.
Corn oil	75 Gm.
Inositol	1 Gm.
Ascorbic acid	1 Gm.
Choline chloride	2 Gm.
Vitamin A	23,000 units
Vitamin D	4,600 units
Alpha-tocopherol acetate	250 mg.
Menadione	100 mg.
Thiamine hydrochloride	60 mg.
Pyridoxine hydrochloride	20 mg.
Calcium pantothenate	300 mg.
Niacinamide	100 mg.
Biotin	1 mg.
Cyanocobalamine	0.1 mg.
Riboflavin	30 mg.
Folic acid	10 mg.
Yeast extract	20 Gm.
Liver powder	20 Gm.
Casein (vitamin-free)	200 Gm.
Cellophane spangles	50 Gm.
Rice flour	580 Gm.

*This diet is a slightly modified version of L-356, a semisynthetic diet on which the original parents of the National Institute of Allergy and Infectious Diseases colony had been maintained at the Lobund Institute, University of Notre Dame. The salt mixture W, the menadione, and the casein were obtained from the Nutritional Biochemicals Corporation, Cleveland, Ohio; vitamins A and D were supplied as Natola, a product of Parke, Davis & Company, Detroit, Michigan; the yeast extract was obtained from the Difco Laboratories, Inc., Detroit, Michigan; the liver powder from Wilson Laboratories, Chicago; and the rice flour (under the name of Cellu) from the Chicago Dietetic Supply House, Inc., Chicago, Illinois.

The germ-free mouse colony was checked for contamination at periodic intervals and at the time the last animal was removed for examination in this study. These are essentially the same bacteriologic techniques that have been recommended for germ-free animals.[3] In addition, tests for the presence of PPLO (pleuropneumonia-like organisms) were also made.[4] Freshly passed feces, material taken directly from the cecum, swabbings of the mouth, and pieces of lung tissue were incubated in a variety of media at several temperatures. No growth of bacteria or fungi was obtained. We do not routinely test for the presence of viruses. Inoculations of various tissues from several samplings of the mouse colony into tissue cultures and suckling mice have not revealed obvious signs of the presence of viruses. However, further samplings and serologic tests will have to be performed before the viral status of the colony is reasonably well understood.

On the basis of weight, general appearance, and reproductivity of the germ-free mice over a period of several years, it appears that the diet is nutritionally adequate. All control animals also received this same autoclaved diet.

Immediately after the animals were killed, their heads were removed and placed in 10 per cent formalin. The heads were later split in a midsagittal plane. One-half was defleshed by the papain method and scored for alveolar bone loss, while the other half was decalcified in 5 per cent formic acid. The latter half was embedded in paraffin and serially sectioned, buccolingually, at 6 micra. The sections were stained with hematoxylin and eosin.

Fig. 1.

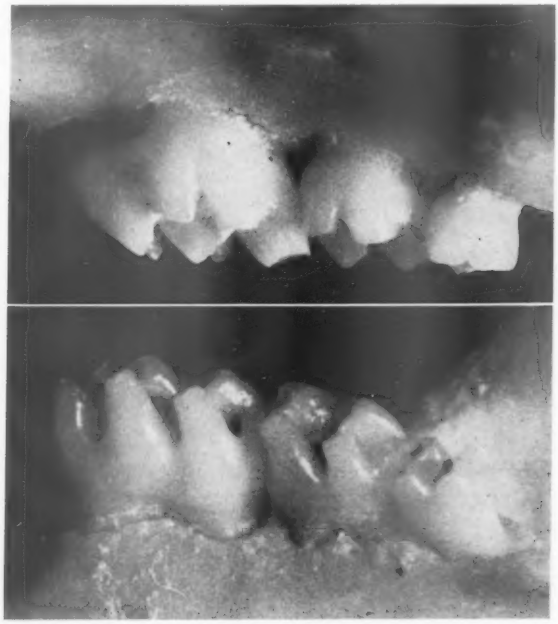


Fig. 2.

Fig. 1.—Palatal view of maxillary molars of 39-day-old germ-free mouse. The level of alveolar bone is the same as in the conventional animal.

Fig. 2.—Lingual view of mandibular molars of 39-day-old germ-free mouse. The level of alveolar bone is the same as in the conventional animal.

FINDINGS

The following descriptions will be limited to the 1- to 3-month and the 6- to 8-month age groups, inasmuch as the 4- to 4½-month-old animals merely exhibited intermediary changes.

Gross Observations Before Defleshing.—The gingival tissues in all age groups of the germ-free and conventional animals and the animals that were first raised germ-free and later "conventionalized" were similar in color, position, and contour. In other words, the gingiva was pink in color, evenly

festooned, and well adapted to the tooth surface. The margin of the gingiva was located on the anatomic crown of the tooth just below the height of contour. Gingival recessions were not observed in any of the animals.

Gross Observations After Defleshing.—

Mice aged 1 to 3 months: In both the germ-free group and the conventional controls, the alveolar bone in the maxillary and mandibular arches was located at approximately the level of the cementoenamel junction. On the mesial surface of the maxillary first molar (Fig. 1) and the lingual surfaces of all the mandibular molars (Fig. 2), the alveolar bone was frequently just slightly apical to this position.

Fig. 3.

Fig. 4.

Fig. 3.—Palatal view of maxillary molars of a 6-month-old germ-free mouse. Note that alveolar bone loss does not occur circumferentially. In the interproximal areas, as well as on the buccal aspect, there is minimal to no bone loss.

Fig. 4.—Lingual view of mandibular molars of a 6-month-old germ-free animal. Note level of alveolar bone in interproximal areas.

Mice aged 6 to 8 months: In all three groups at this age considerable loss of alveolar bone was evident in both arches and about all the molar teeth. In some instances, this resulted in exposure of more than one-half the root length. The alveolar bone loss, however, did not occur circumferentially but was limited to the straight palatal surface of the maxillary molars (Fig. 3) and the straight lingual surface of the mandibular molars (Fig. 4). In the interproximal areas of these surfaces, as well as on the entire buccal surface, the alveolar bone was

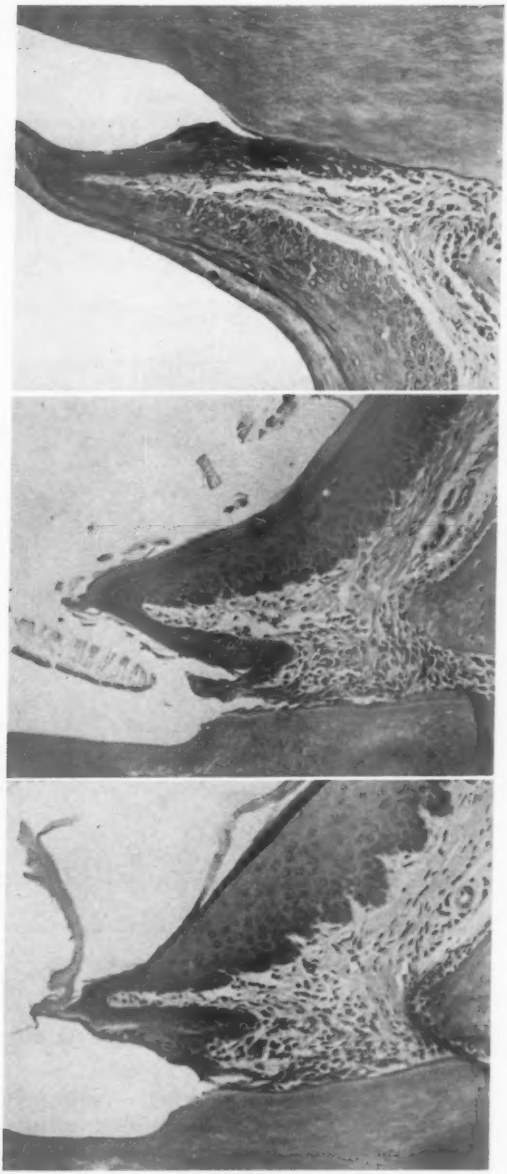
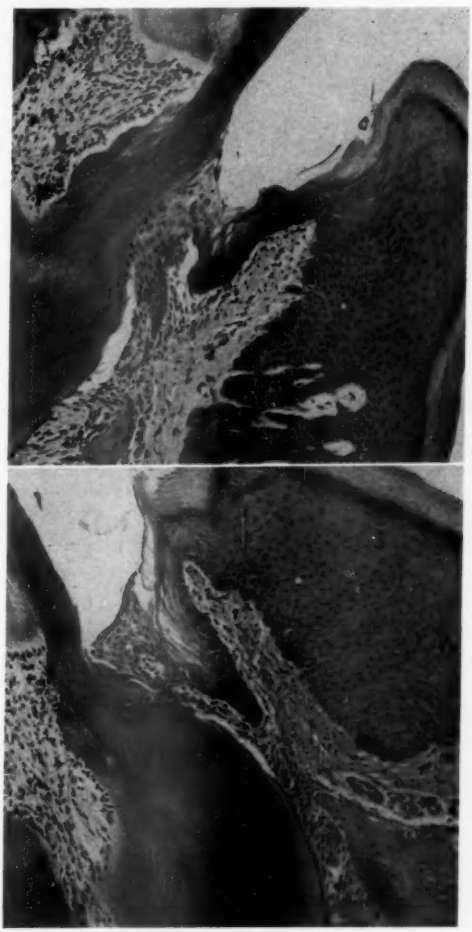


Fig. 5.—Typical sections showing downgrowth of the epithelial attachment on the lingual surface in animals 6 to 8 months of age. *A*, First molar of a germ-free mouse; *B*, first molar of a conventional mouse; *C*, first molar of a mouse that was raised germ-free for four months and then conventionalized for an additional three months; *D*, third molar of a germ-free mouse; *E*, third molar of a conventional mouse.

(D and E on opposite page.)

intact and located at approximately the level of the cementoenamel junction. The incidence and severity of the periodontal disease, as measured by alveolar bone loss, appeared to be approximately the same whether the animal was raised in a germ-free or a conventional environment (Table II).

D.



E.

Fig. 5.—Cont'd. *(For legends, see opposite page.)*

Microscopic Observations.—

Mice aged 1 to 3 months: In the three groups, in buccolingual sections and mesiodistal sections, the epithelial attachment was located at the cementoenamel junction where it formed a butt joint with the most coronal portion of the

TABLE II. COMPARATIVE ALVEOLAR BONE LOSS IN GERM-FREE AND CONVENTIONAL MICE 6 TO 8 MONTHS OF AGE

TYPE OF ANIMAL	NUMBER OF ANIMALS	SCORE*	
		TOTAL	AVERAGE
Germ-free	8	80	10
Conventional	10	57	6
Germ-free and then conventionalized	5	35	7

*Maximum score possible (most severe periodontal disease) is 24 per animal. (For scoring technique, see Baer, P. N., and Lieberman, J. E.: ORAL SURG., ORAL MED. & ORAL PATH. 12:820-829, 1959.)

cementum. The sulcular epithelium was smooth in appearance, and the underlying connective tissues were free of inflammation. The alveolar crest was slightly apical to the cementoenamel junction.

Mice aged 6 to 8 months: In buccolingual sections in all three groups the following changes were observed: The epithelial attachment on the lingual surface of the molars in both jaws was located on the cementum at a considerable distance from the cementoenamel junction. Loss of bone at the alveolar crest was evident. The sulcular epithelium was intact, however, and only a small degree of inflammation was noted in the underlying connective tissues. Typical examples of the attachment on the lingual surfaces of germ-free, conventional, and a combination of germ-free and conventional animals are shown in Fig. 5, *A* to *E*. On the buccal aspect, on the other hand, the epithelial attachment was broad and extended apically from the cementoenamel junction for a depth of only four or five cells. The rete pegs, emanating from the sulcular epithelium, were seen projecting into the underlying connective tissue. This underlying tissue, however, exhibited only a small degree of inflammation.

In contrast with the findings on the lingual surface, no loss of bone at the alveolar crest was evident on the buccal surface. The relative heights of the alveolar crest on the buccal and lingual surfaces are shown in Fig. 6.

In mesiodistal sections, however, the three groups resembled the younger ones in that the epithelial attachments were located at the cementoenamel junction where they formed a butt joint with the most coronal portion of the cementum (Fig. 7). The lining epithelium was intact, the underlying connective

TABLE III. THE RELATIONSHIP OF AGE TO THE OCCURRENCE OF PERIODONTAL DISEASE

TYPE OF ANIMAL	AGE (MONTHS)	NUMBER OF ANIMALS	NUMBER SHOWING PERIODONTAL DISEASE	PER CENT
Germ-free	1-3	14	0	0
	4-4½	16	7	44
	6-8	8	8	100
Conventional control colony*	1-3	6	0	0
	4-4½	10	3	30
	6-8	10	10	100
Ex-germ-free†	6-8	5	5	100

*Conventional colony established from the germ-free mice and maintained on the same sterilized diet.

†Germ-free for periods of four to five months and then "conventionalized" for two to three months. Diet identical to that given above two groups.

tissue was normal in appearance, and the alveolar crest was at its normal height, just slightly apical to the cementoenamel junction.

The onset of the periodontal changes, as shown in Table III, occurred between the third and fourth months. This table includes both male and female animals, inasmuch as no sex differences were noted.

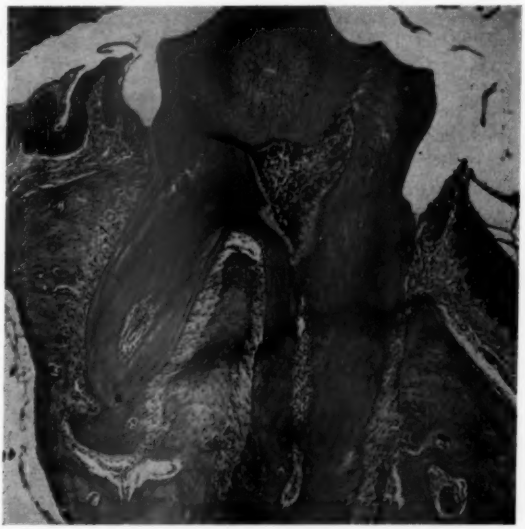


Fig. 6.—Note that the crest of the alveolar bone on the buccal surface, to the left of the tooth, is at a much higher level than the alveolar crest on the lingual surface, to the right of the tooth.

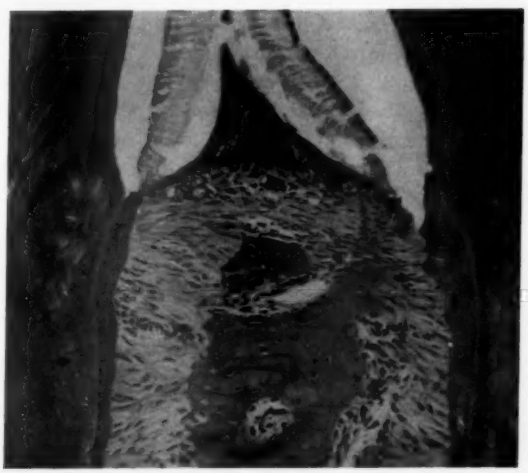


Fig. 7.—Mesiodistal section from a 7-month-old germ-free mouse showing the level of the epithelial attachment and the height of the crest of the alveolar bone. Compare with Fig. 5.

Hard deposits (calculus) were observed on the anatomic crowns of the maxillary molars in all three groups of mice. There was no apparent difference between the germ-free and conventional groups. The deposits tended to be more abundant on the mesiolingual surface of the maxillary first molar, and they appeared to originate just above the height of contour of the crown of the tooth, which is at or slightly above the level of the margin of the gingiva. The calcareous deposits stained red with an aqueous solution of alizarin red S, showing that they contained calcium.

DISCUSSION

Although there are many theories as to how a periodontal pocket forms, there is general agreement that both the dissolution of the gingival group of fibers and the apical migration of the epithelial attachment are necessary for pocket formation. The only real disagreement among investigators is over which of these processes comes first. Several[5-8] have pointed to the importance of bacteria, bacterial enzymes, or toxins in periodontal disease. It has even been suggested that the first step in pocket formation is brought about by the invasion of bacteria at the base of the sulcus.[5]

While it is certainly not our intention to underestimate or in any way to understress the importance of the oral bacterial flora in periodontal disease, nevertheless we have observed that both apical proliferation of the epithelial attachment and loss of alveolar bone occur in mice raised in a bacteria-free environment on an apparently nutritionally adequate diet. Furthermore, neither the conventional animals nor the mice which were first raised germ-free and later conventionalized showed any periodontal changes which were significantly different from those seen in the animals which were raised entirely in a germ-free environment.

As in the conventional animal, the mechanism which triggers downgrowth of the epithelial attachment in the germ-free animal is unknown. If one wishes to speculate, however, several hypotheses do suggest themselves. For instance, although neither hair nor food impaction was observed to occur in these mice, calculus was usually present on the crowns of the molars. Furthermore, the calculus was invariably in close approximation to the margin of the gingiva. One could assume, therefore, that the calculus, or possibly some other local factor, might have acted as a very mild irritant which initiated epithelial proliferation. The epithelial attachment could then have migrated apically between the intact bundles of the gingival fiber group, enmeshing them in an epithelial network and thus producing secondary degeneration of the connective-tissue fibers.[9]

Another possibility, however, is that the dissolution of the connective-tissue fibers might have occurred as a result of altered local-tissue metabolism. Any irritant, no matter how slight, may initiate a nerve reflex in the epithelium.[10] This, in turn, could have caused vascular changes in the underlying connective tissue and thus altered the local metabolism.

The reason for the loss of alveolar bone on the lingual and palatal surfaces of the molars is unknown at present. Studies are underway in our laboratory, however, on various aspects of this problem. We have already been able to show that the susceptibility to alveolar bone loss is, in part at least, under genetic[11, 12] and nutritional influences.[13]

In a recent publication[14] on age changes in the periodontium of albino mice, it was observed that the distance between the crests of the alveolus and the cementoenamel junction is increased in old animals. The reason suggested for this is that "the rate of bone apposition at the alveolar crests does not keep pace with occlusal eruption of the teeth." This explanation is hardly applicable to our findings, however, as the alveolar bone in our mice was not lost circumferentially but only on the straight lingual and palatal surfaces. On the entire buccal surface, as well as on the palatal and lingual interproximal areas, the alveolar bone was present at its normal level.

Calculus formation in a germ-free environment is much easier to explain. As suggested by one of us (P. N. B.) in an earlier publication,[11] the enzyme, esterase, is found in deposits on teeth. The enzyme occurs not only in bacteria but also in epithelial cells, polymorphonuclear leukocytes, and macrophages. Esterase is capable of hydrolyzing esters of fatty acids, and in this way fatty acids are released. These could then combine with calcium and magnesium to form soaps. These soaps, in turn, might later become converted into the less-soluble forms of carbonate and phosphate. This mechanism would be capable of operating in a germ-free environment and could explain the formation of calculus on the tooth surface.

CONCLUSIONS

1. Downgrowth of the epithelial attachment and loss of alveolar bone were observed to occur in germ-free animals as well as in the conventional controls.

2. These changes were confined almost entirely to the straight palatal surface of the maxillary molars and the straight lingual surface of the mandibular molars.

3. Inflammation did not appear to play an important role in the periodontal changes noted.

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12. Baer, P. N., Jay, G. E., Jr., and Lieberman, J. E.: Studies on Periodontal Disease in the Mouse. II. Effect of Genetics (in preparation).
13. Baer, P. N., and White, C. L.: Studies on Periodontal Disease in the Mouse. I. Effect of Age, Sex, Cage Factor, Diet, J. Periodont. 31: 27, 1960.
14. Gilmore, N. D., and Glickman, I.: Some Age Changes in the Periodontium of the Albino Mouse, J. D. Res. 38: 1195, 1959.
15. Baer, P. N., and Burstone, M. S.: Esterase Activity Associated With Formation of Deposits on Teeth, ORAL SURG., ORAL MED. & ORAL PATH. 12: 1147, 1959.

Erratum

In the article entitled "Hyperparathyroidism First Suspected Through a Giant-Cell Epulis" by Attie and Blum, which begins on page 482 of the April, 1960, issue of the JOURNAL, the following should have been included in the reference list on page 492:

15. Kaletsky, T., Ottenberg, R., and Blum, T.: Hyperparathyroidism, Arch. Clin. Oral Path. 3: 166, 1939.
16. Case Report: Giant-Cell Tumor of Mandible Associated With a Parathyroid Adenoma, Arch. Clin. Oral Path. 1: 124, 1937.

ANNOUNCEMENTS

New York Institute of Clinical Oral Pathology, Inc.

The Institute announces that the ninth Herman L. Reiss Memorial Lecture will be held at the New York Academy of Medicine Building, 2 East 103rd St., on Monday, Oct. 31, 1960, at 8:30 P.M. The essayist will be Harry Sicher, M.D., D.Sc., chairman of the Departments of Anatomy and Histology, Loyola University, School of Dentistry, Chicago, Illinois. Dr. Sicher will lecture on the subject of "Anatomy and Oral Pathology."

Members of the dental, medical, and allied professions are cordially invited.

Southern California Academy of Endodontists

The Southern California Academy of Endodontists will hold its annual all-day scientific meeting at the Beverly Hills Hotel in Beverly Hills, California, On Saturday, Oct. 15, 1960, preceding the 1960 meeting of the American Dental Association.

An all-morning symposium on aspects of dental pain will be followed by a luncheon seminar. In the afternoon guest speaker Harold A. Maxmen of Detroit, Michigan, will discuss "The Rationale of Surgical Intervention in Endodontics, Including Periapical Pathology."

Attendance is limited to 200. Checks for the $10.00 registration fee (which includes the luncheon) should be mailed to Dr. Sanford Golden, Program Chairman, 1001 Gayley Ave., Los Angeles 24, California.

New York State Dental Society of Anesthesiology

The New York State Dental Society of Anesthesiology, in cooperation with the Grand Central Hospital Departments of Dentistry and Anesthesia, will present its fifth Postgraduate Assembly at Grand Central Hospital, 321 East 42nd St., New York City, on Friday, Sept. 16, 1960. The topic will be "The Physiologic Response of the Anesthetized Patient to Dental and Oral Surgical Manipulation."

The registration fees for the Assembly are $5.00 for nonmembers and $2.00 for members. Checks payable to the New York State Dental Society of Anesthesiology should be sent to the organization's secretary, Dr. Benjamin Schweid, 11 Pilgrim St., New Hyde Park, Long Island, New York.

First District Dental Society

The Section on Oral Surgery will meet on Wednesday, Oct. 19, 1960, at 8 P.M. at the Hotel Statler in New York City. Fred Rothenberg will present a paper on "Supernumerary Teeth and Their Effect Upon the Dentition and Normal Occlusion."

University of Illinois

The College of Dentistry, Division of Postgraduate Education, will offer a concentrated two-week course in oral surgery beginning Nov. 7, 1960. The course will consist of lectures, clinical presentations, and television demonstrations designed to cover all phases of exodontia and oral surgery. It will include treatment of cysts, apicoectomy, mouth preparations for dentures, removal of impactions, management of fractures, and care of the hospitalized dental patient. The lectures will cover applied pharmacology, anesthesiology, and radiology. The course, which is planned primarily for the dentist in general practice, will be presented by faculty members of the Colleges of Dentistry and Medicine under the direction of Dr. Daniel M. Laskin, associate professor of oral surgery. Tuition is $150.00.

A concentrated one-week course in premedication and general anesthetic techniques will begin on Dec. 5, 1960. This course will consist of lectures, demonstrations, and clinical work. Designed for dentists who use general anesthetics in their practice, the course will be directed by Dr. Elaine Stuebner of the Department of Oral and Maxillofacial Surgery. The faculty will include Dr. A. G. Anderson, head of the Department of Oral and Maxillofacial Surgery, and Dr. Max Sadove, head of the Division of Anesthesiology. Tuition is $125.00, and attendance will be limited to fifteen.

Further information and applications may be obtained from the Division of Postgraduate Education, University of Illinois College of Dentistry, 808 South Wood St., Chicago 12, Illinois.

New York University

New York University College of Dentistry will give five short courses for practicing dentists in denture prosthesis and endodontia during the 1960-61 academic year.

According to Dr. Earl O. Butcher, assistant dean at the College, "The courses are offered to accommodate dentists who are able to be away from their practices for only a few days."

The courses and their dates are as follows:

Endodontia, December 1 and 2. (This course, to be given just prior to the Greater New York Dental Meetings, will emphasize new developments in the treatment of vital and nonvital teeth.)

Complete Denture Participation, January 16 to 20.

Immediate Dentures, February 15 to 17.

Dental Obturators, March 15 to 17.

Partial Dentures, April 19 to 21.

Temple University

A course in clinical endodontics will be presented at Temple University School of Dentistry Oct. 31 to Nov. 5, 1960, under the direction of Dr. Leonard Parris. Closed-circuit television will be used for the clinical demonstrations. Single- and multi-rooted teeth will be treated. Enrollment is limited to ten. Tuition is $175.00.

For further information and application, write to Dr. Louis Herman, Director of Postgraduate Studies, Temple University School of Dentistry, 3223 North Broad St., Philadelphia 40, Pennsylvania.

Internships and Residency at Grand Central Hospital

Two rotating internships will be available in July, 1961, at Grand Central Hospital in New York City. Internship includes training in prosthetics, root canal, orthodontics,

crown and bridge, maxillofacial prosthetics, general anesthesia, operative dentistry under general anesthesia, exodontia, and oral surgery with rotation to Morrisania City Hospital. The department is certified by the American Dental Association.

An anesthesia residency for a dentist will be available at Grand Central Hospital in July, 1961. A background of internship is required.

Application should be made to Dr. Bernard M. Cohen, Director, Department of Dentistry, Grand Central Hospital, 321 East 42nd St., New York, New York.

Surgical Internship at Morrisania City Hospital

An American Dental Association accredited surgical internship will be available for July, 1961, and June, 1962. Application should be made to Morrisania City Hospital, Bronx, New York.

American Academy of Maxillofacial Prosthetics

The Academy will hold its ninth annual meeting at the Sheraton-West Hotel (Sheraton Town House) in Los Angeles, California, Oct. 20 to 22, 1960. Any interested member of the American Dental Association or of a foreign dental association will be welcome as a guest.

Further information may be obtained from Dr. Mervin C. Cleaver, Executive Secretary, 2330 Linwood Ave., Apt. 3H, Coytesville, New Jersey.

Oral Pathology Archives Now Available

Sets of unbound volumes of the *Archives of Clinical Oral Pathology* (1937-1940) are now available to the profession. The 1,425 pages of profusely illustrated text of original communications relate to dental and oral, basic and clinical sciences. The contents include clinical case reports, editorials, abstracts of oral pathology, historical data, and (of special importance) the George B. Winter Memorial Issue. The set of four volumes is priced at $10.00.

For information, write to the New York Institute of Clinical Oral Pathology, 101 East 79th St., New York 21, New York.

University of Alabama

The School of Dentistry will offer two refresher courses during the month of November, 1960:

Root Canal Therapy. November 5 to 7. Adeeb E. Thomas, D.M.D.

Major Oral Surgery. November 12 to 14. Colonel Robert B. Shira, DC, USA. (Limited to oral surgeons.)

Further information may be obtained from the Director, Refresher Course Program, University of Alabama School of Dentistry, 1919 7th Ave. South, Birmingham, Alabama.

Ohio State University

The College of Dentistry will repeat its 1960-1961 postgraduate courses in dentistry. Among the courses to be offered are the following:

General Anesthesia. Oct. 31 to Nov. 4, 1960; May 15 to 19, 1961. Dr. Morgan L. Allison. Fee, $75.00.

Oral Surgery. Nov. 28 to Dec. 2, 1960; May 22 to 26, 1961. Dr. Morgan L. Allison. Fee, $75.00.

Endodontics. March 6 to 10, 1961. Dr. J. Henry Kaiser. Fee, $100.00.

Hypnosis in Dentistry. April 10 to 12, 1961. Dr. Charles M. Pfersick. Fee, $75.00.

Periodontics. April 13 to 15, 1961. Drs. John R. Wilson and William V. Walton. Fee, $75.00.

Dental Drugs in Action. May 19 and 20, 1961. Dr. W. Russell Kampfer. Fee, $25.00.

Enrollment in each course is limited to ten or twelve, except for the participation course in endodontics which is limited to five students.

Further information may be secured from the Postgraduate Division, College of Dentistry, 305 West Twelfth Ave., Columbus 10, Ohio.

Loyola University

Loyola University School of Dentistry, the Chicago College of Dental Surgery, is offering a research and teacher-training program in oral biology. This is under a teacher-training grant from the National Institutes of Health. It is designed for candidates desiring a teacher's career in basic sciences or in clinical subjects. The stipends are up to $5,000.00 per year, and the program can lead to an advanced degree.

For further information, write to Dr. Harry Sicher, Director, Loyola University School of Dentistry, 1757 W. Harrison St., Chicago 12, Illinois.

University of California

The University of California Extension Dental Program, in conjunction with the American Academy of Implant Dentures, is giving a three-day clinic on denture implants at 815 South Hill St., Los Angeles, California, immediately preceding the 101st annual session of the American Dental Association.

The time will be from 9 A.M. to 4 P.M., Oct. 14, 15, and 16, 1960. The clinic will include a closed-circuit television presentation of actual denture implant operations on two patients. In addition, there will be various table clinics, seminars, and film presentations.

For further information, contact University of California Extension Dental Program, Room 211, 815 South Hill St., Los Angeles 14, California.

REVIEWS OF THE LITERATURE

ABSTRACTS OF CURRENT LITERATURE

Chemotherapy of Cancer. J. D. Hurley and F. M. Hall. A. M. A. Arch. Surg. **80:** 928, June, 1960.

There are many cancer patients for whom surgery and radiation therapy are not permanently helpful. The over-all end results reported in collected series from large centers seldom show a five-year survival rate exceeding 30 per cent in patients who have had surgery, radiation therapy, or both.

"The chemical agents useful in the treatment of patients with cancer are not curative and they do not control the disease indefinitely. In exerting measurable and predictable effects on certain forms of neoplastic disease, however, they may prolong life, relieve discomfort, and temporarily restore the patient to apparently normal health."

The authors studied 387 patients with solid tumors and found the chemotherapeutic agents to be toxic and at times to cause a marked leukopenia and stomatitis. In the discussion of this paper, Dr. R. Lee Clark, Jr., stated: "There is great interest in cancer chemotherapy, and in the past five years in the national program over 40,000 drugs have been screened, approximately 100 being deemed suitable for use in humans." Hope for the future development of chemotherapeutic agents for cancer is expressed by the investigators.

T. J. C.

Rehabilitation After Partial Glossectomy. L. E. Rosenthal, R. Boyer, J. V. Lane, and S. L. Lane. J. Pros. Dent. **10:** 270, March-April, 1960.

"Following hemiglossectomy and radical neck dissection for malignancy of the tongue and associated structures, the patient experiences residual speech impairment, disturbed deglutition and mastication, and social and psychologic handicaps."

The authors describe a method of correcting the defect caused by suturing the remaining portion of the tongue to the crest of the alveolar ridge.

As a presurgical procedure, an impression is made with an alginate impression material and a plaster of Paris cast is poured. Modification of the cast, fabrication of the stent, sterilization of the appliance, and the surgical technique are described in detail.

The article is well illustrated and is recommended to the oral surgeon.

T. J. C.

Alpha Amylase as an Anti-inflammant in Dentistry. W. S. Monica. Acad. Med. N. J. Bull. **5:** 4, December, 1959.

This is a preliminary report on a buccal enzyme used to control inflammation. Fifty-three patients were treated by extraction of teeth, and/or deep scaling for cellulitis, pericoronitis, etc. Forty of the fifty-three had excellent results and twelve had good results in the control of inflammation and pain with alpha amylase. None had side effects.

Alpha amylase in a 10 mg. buccal tablet was placed in the inferior labial vestibule three times daily between meals and allowed to dissolve slowly. The tablets were used from one to seven days postoperatively.

T. J. C.

Elective Neck Dissection for Intraoral Cancer. H. W. Southwick, D. P. Slaughter, and E. T. Trevinto. A. M. A. Arch. Surg. **80:** 905, June, 1960.

Anatomically, intraoral cancer lends itself to regional node dissection accompanying the removal of a primary epithelial tumor.

The frequency of microscopic node involvement at the time of primary treatment of squamous-cell carcinoma of the tongue and floor of the mouth is high. In this study, 50 per cent of the patients exhibited such evidence of disease. A regional node dissection should be performed, preferably in continuity, in the treatment of primary tumors of the tongue and floor of the mouth when the patient's general health does not contraindicate such an operation.

T. J. C.

Surgery for Radiation Injury. D. W. Robinson and F. W. Masters. A. M. A. Arch. Surg. **80:** 946, June, 1960.

In this interesting article the authors discuss induced malignancy following irradiation of benign lesions, extensive radiation for cancer, and accidental injury. Over periods of many years ten dentists had held dental films in the mouths of their patients, and the resulting lesions occurred on the index finger, the thumb, and sometimes the middle finger. Physicians and dentists made up the great majority of the accidental injured group. The chief complaint was roughness of the skin in 29 per cent, with pain and ulcer each occurring in 26 per cent.

T. J. C.